Mini-Micro Systems

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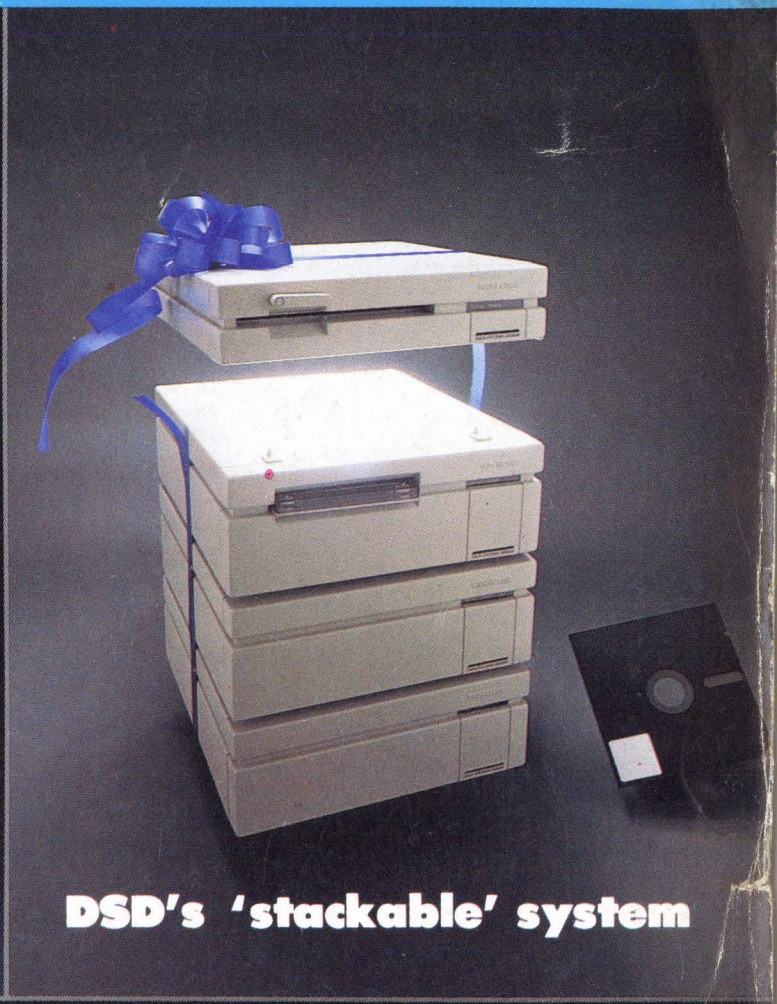
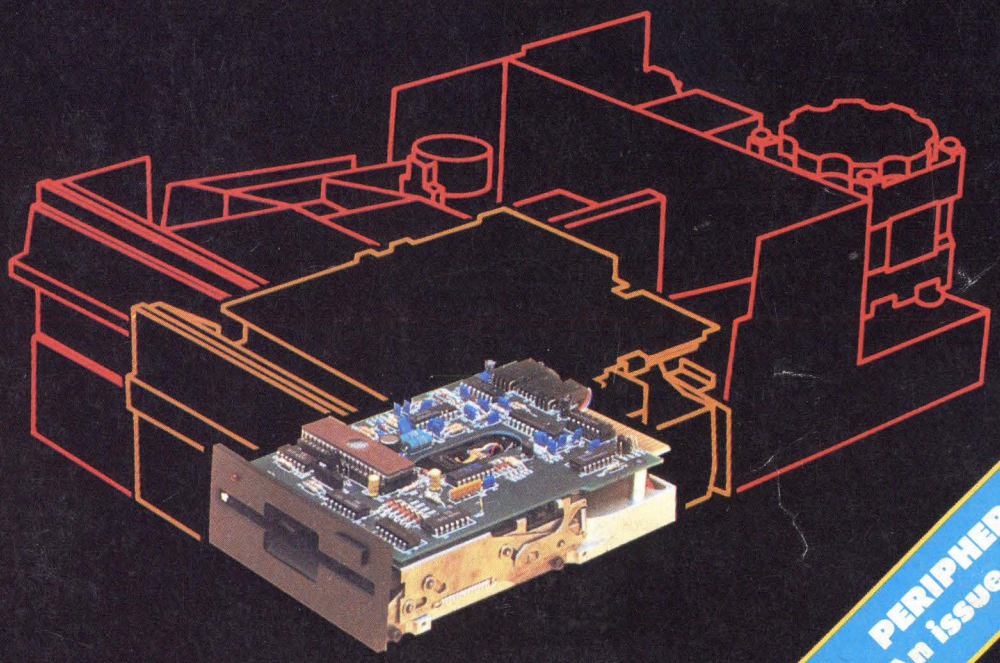
NOVEMBER 1982

Vertex drives for capacity



DSD's 'stackable' system

Tandon shrinks a microfloppy



PERIPHERALS DIGEST
An issue within an issue

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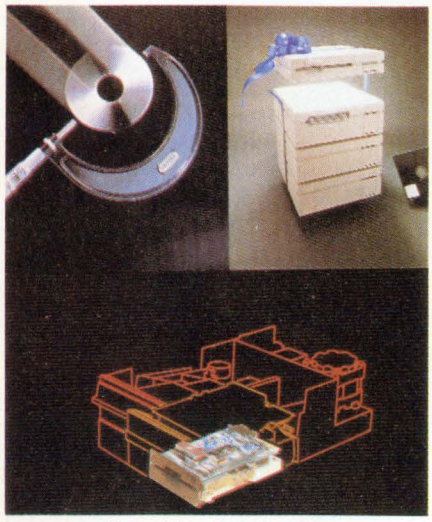
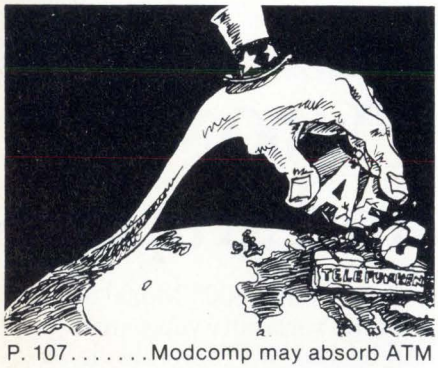


Two new disk drives and a storage subsystem are featured on the cover. The drives are representative of trends chronicled in the Peripherals Digest (p. 226). One is the trend toward ever-higher Winchester capacities represented at top left by a 74M-byte entry from Vertex Peripherals, Inc. The other trend is toward progressively smaller dimensions in diskette drives, symbolized by Tandon Corp.'s evolution at bottom center, whose latest generation uses 3½-in. diskettes. At top right is Data Systems Design's packaging concept (p. 34). Cover design by Vicki Blake; photos courtesy of Vertex Peripherals, Tandon Corp. and Data Systems Design.



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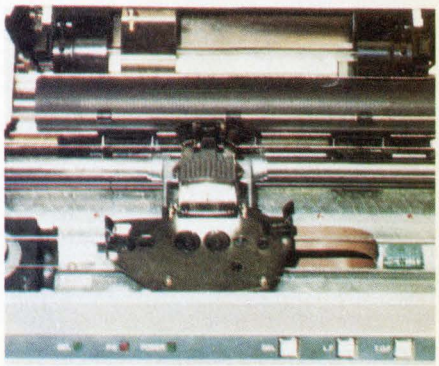

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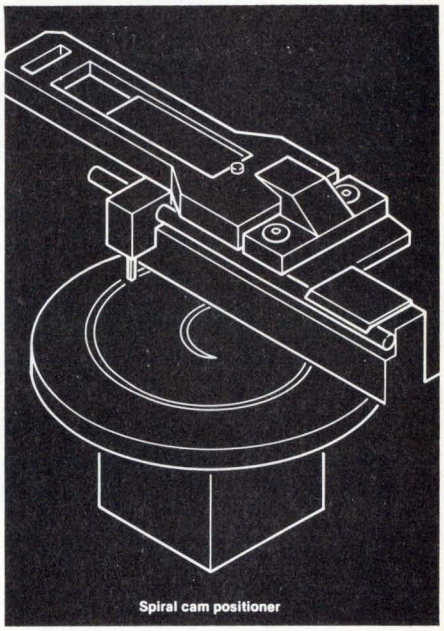

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MINI-MICRO SYSTEMS (ISSN 0364-9342) is published monthly by Cahners Publishing Company, Division of Reed Holdings, Inc., 221 Columbus Avenue, Boston, MA 02116. Norman L. Cahners, Chairman; Saul Goldweitz, President; Ronald G. Segel, Financial Vice President and Treasurer. MINI-MICRO SYSTEMS is published by the Cahners Magazine Division: J. A. Sheehan, President; William Platt, Executive Vice President; H. Victor Drumm, Group Vice President. Circulation records are maintained at Cahners Publishing Co., 270 St. Paul St., Denver, CO 80206. Second class postage paid at Denver, CO 80202 and additional mailing offices. Postmaster: Send address changes to MINI-MICRO SYSTEMS, 270 St. Paul St., Denver, CO 80206. MINI-MICRO SYSTEMS is circulated without charge by name and title to U.S. and Western Europe based corporate and technical management, systems engineers, and other personnel who meet qualification procedures. Available to others at the rate of $35.00 per year in the U.S.; $40.00 in Canada and Mexico; $65.00 in all other countries (12 issues). Single issues $4.00 in the U.S.; $5.00 in Canada and Mexico; $6.00 in all other countries.

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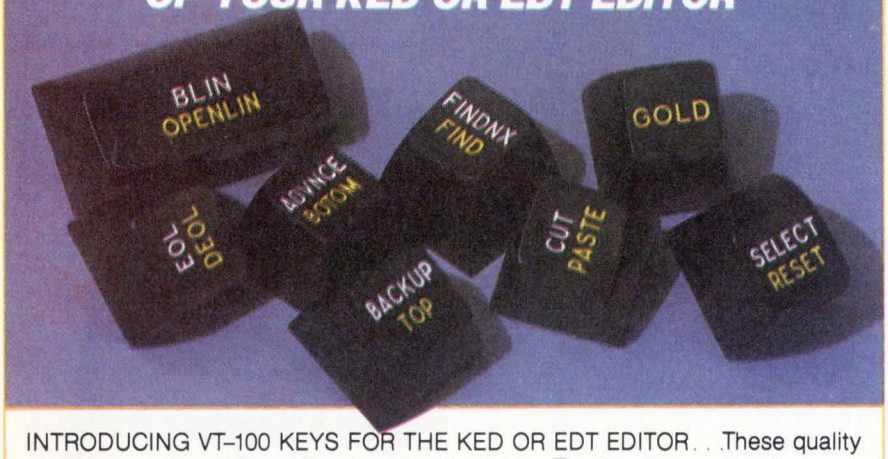

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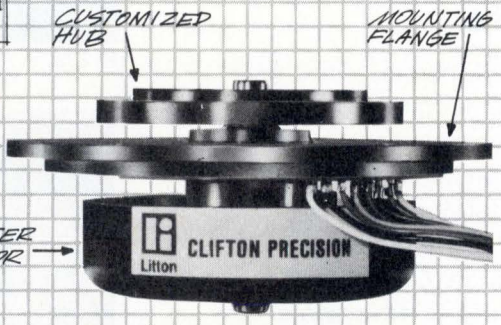

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Reprints of Mini-Micro Systems articles are available on a custom basis at reasonable prices in quantities of 500 or more. Contact Art Lehman, Cahners Reprint Service, Cahners Plaza, 4350 E. Touhy Ave., P.O. Box 5080, Des Plaines, IL 60018; (312) 635-8800.

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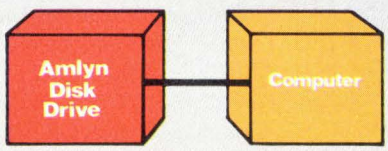

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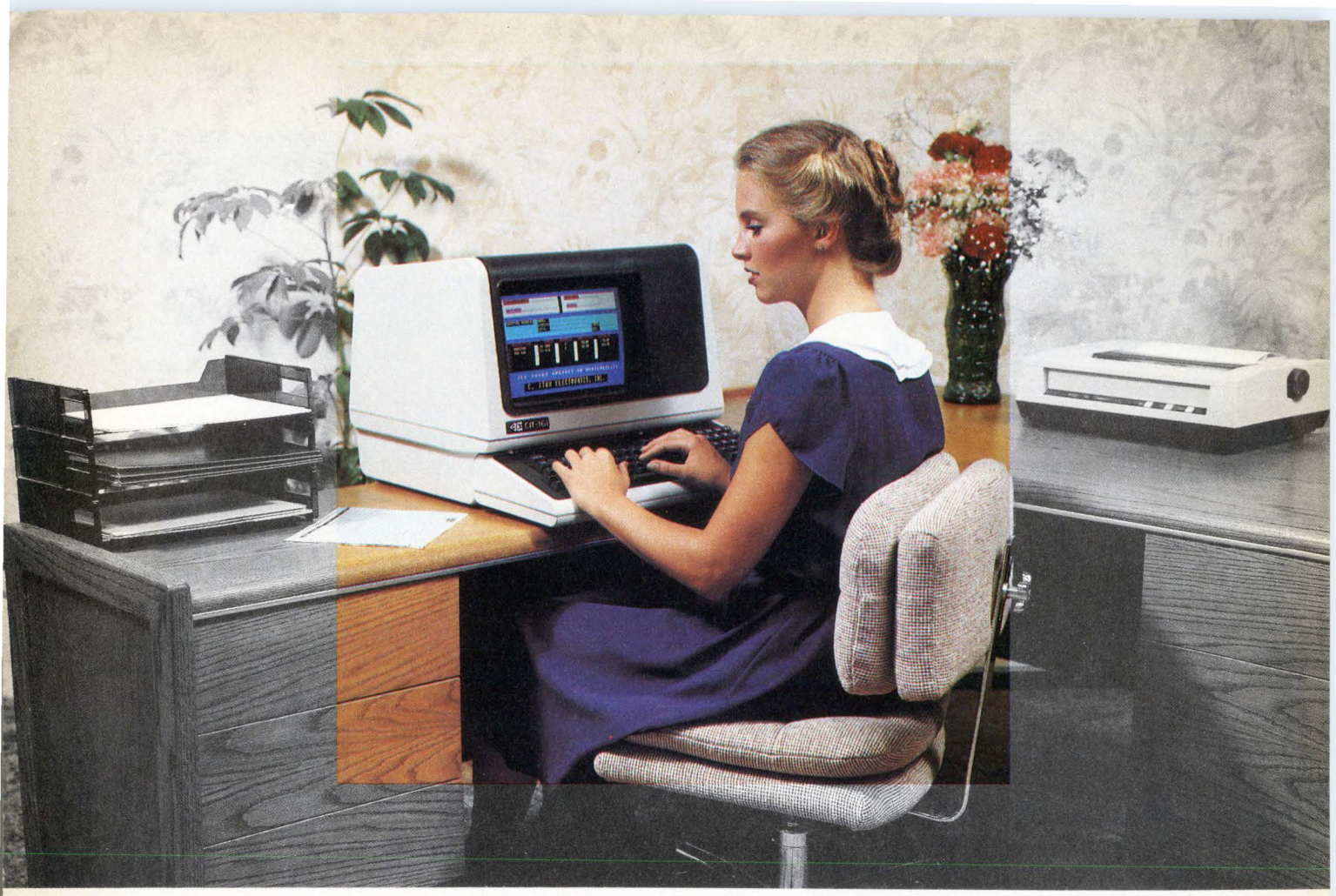

Some interesting things happen when you sit down at our CIT-161 Terminal.

Like any office worker, video terminal operators are bombarded by a tremendous spectrum of visual and audio stimulae. Add to that their own thought distractions and you begin to see why a single-color display is at a severe disadvantage competing for user attention.

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Breakpoints

ARE NEW APPLE DRIVES INCOMPATIBLE WITH EXISTING MEDIA?

In a move ostensibly aimed at discouraging software piracy, Apple Computer, Inc., Cupertino, Calif., reportedly is close to production of a 5¼-in. floppy disk drive rumored to use a unique read/write head arrangement that could make existing floppy media useless with future Apple computers. An Apple spokesman confirms the existence of such a high-density drive and says it may appear at Comdex, Nov. 29–Dec. 2 in Las Vegas. The spokesman says the company intends to provide continuing support for users of existing drives and media used on Apple computers. Plans for that support are not firm, although, the spokesman notes, one method would be to use an internal drive with one type of media and an external drive with another. Sources say Apple is seeking bids on heads for the double-sided drives built at its Newbury Park, Calif., facility. Two pressure-pad heads are used, one on each of the drive's hubs and on opposite sides of the media. The setup calls for a special diskette jacket said to be in development at media maker Dysan Corp. Besides physical incompatibility with existing floppy drives, Apple has included some software interlocks, sources say, that would further prevent software on conventional media from being used with the new hardware. The drive is reportedly not stretching capacities, however, and has a 40-msec. access time and 62.5-tpi track density.

UNGERMANN-BASS NETWORK BRIDGES LINK MIXED-MEDIA SYSTEMS

Local-area-network supplier Ungermann-Bass, Santa Clara, Calif., this month will introduce local and remote network bridges to interconnect its Net/One LAN systems. The remote bridge interconnects widely separated networks via high-speed communications links; the local bridge connects networks in small environments. As many as 100 baseband, broadband or combination Net/One LANs can be linked using any combination of local or remote bridges, company executives say. As many as five frequency channels in a broadband cable can communicate with each other. Each bridge contains a 12K-byte buffer for store-and-forward operations. The remote bridge consists of a network interface unit and a new high-speed serial I/O module. The remote bridge sells for $6200; software is priced at $1000 to $2000 per network. The local bridge consists of an NIU plus transmitter, receiver and processor functions for the connected networks. Prices for the local bridge have not been set. Remote bridges will be shipped this month; local bridges will be shipped in February.

QUME TO INTRODUCE UPGRADED SPRINT 11 AT COMDEX

Look for Qume Corp. to unveil an upgrade to its Sprint 11 daisy-wheel printer at Comdex. The new Sprint 11 PLUS is designed modularly. The printer operates at 40 cps and comes with "Qume-connection" plug-in interface modules offering RS232C, Centronics-compatible or IEEE-488 ports. The company terms the PLUS a low-priced word-processing printer with quality and longevity rivaling high-priced offerings, and plans to target it at business and personal-computer end users and OEMs. MTBF testing is still in progress, but Qume says the printer is expected to reach at least 5000 hours before failure. The $1776 single-unit price will be the company's lowest. Qume's current lowest priced printer is the $2250 Sprint 9. Qume will discuss OEM pricing on an individual basis. Production quantities are expected by December.

DG CHALLENGE TO DEC's LOW-END VAX EXPECTED

A low-end superminicomputer expected to give Digital Equipment Corp.'s VAX-11/730 a strong price/performance challenge is targeted for introduction mid-month by Data General Corp. Called the MV/4000, the 32-bit computer will be available to OEMs through DG's Technical Products division, and is expected to be released in a fully configured version as well. The MV/4000 will run the full Eclipse MV/8000 instruction set and the AOS/VS operating system, so it will be compatible with other MV/products on the market. Pricing information was not available at press time.

DEC TO OFFER PRO IV 'NO-CODE' PROGRAMMING SYSTEM

Digital Equipment Corp. plans to adopt the Pro IV package for a variety of systems that reportedly will range as low as the Z80/8088-based Rainbow 100 personal computer and as high as the VAX superminicomputer. The package, which has been implemented on General Automation, Microdata and CIE Systems products (MMS, January, p. 33), is said to provide about 140 functions to cover business

computing applications. Its supplier, Data Technical Analysts, claims it can be used to develop programs in a fraction of the time required in high-level language application development. Pro IV, Inc., Littleton, Mass., which recently hired former DEC Small Systems Group applications development manager Tom Campbell as president, is performing the implementation on DEC hardware. The first version for the RSX-11 operating system is due out by year-end. A version for the Professional 325/350 personal computers will follow, and Pro IV reportedly is negotiating a package for the VAX VMS operating system. Capro, a Garden Grove, Calif., firm with exclusive rights to sell implementations on Intel processors, is reportedly working on separate negotiations to get Pro IV on the Intel 8088 portion of the Rainbow.

RYAN-McFARLAND CONTINUES DRIVE IN SUPERMICRO MARKET

Ryan-McFarland Corp.'s RM/COS operating system is gaining momentum as an alternative to UNIX for Motorola MC68000-based supermicrocomputers, and CIE Systems reportedly is close to signing a deal for it. CIE, which has been firmly in the UNIX camp, has dropped the Motorola VERSAdos operating system it had supported as a UNIX alternative. If CIE signs, it will join a growing list of MC68000 systems, including Altos Computer Systems, Wicat Systems and Callan Data Systems, all of which recently hopped on the Ryan-McFarland bandwagon.

NCR TARGETS OEMs WITH MC68000-BASED SYSTEM

NCR Corp. this month is scheduled to join the swelling ranks of computer vendors offering Motorola MC68000-based systems running the UNIX operating system. The NCR version, designated the Tower 16/32 for its vertical packaging, is the Dayton, Ohio, firm's first major foray into the OEM/systems house market and follows the formation last year of an OEM marketing division. The Tower is expected to run the UNIDOL implementation of Western Electric's UNIX System III. UNIDOL is supplied by Science Management Corp., Bridgewater, N.J., which is also expected to provide NCR with Basic Four-compatible Business BASIC and its IDOL database-management system, thereby producing a package similar to the Fortune 32:16. NCR also is believed to be discussing use of Ryan-McFarland Corp.'s RM/COS operating system and RM/COBOL to provide links to NCR's 8100 minicomputer, of which the IMOS operating system and COBOL were developed by Ryan-McFarland.

SHUGART CONTROLLERS USE CUSTOM LSI CHIP SET

This month, Shugart Associates, Sunnyvale, Calif., will introduce a series of disk-drive controllers that use a custom LSI chip set to implement its Shugart Associates System Interface. Called the SA1600 series, the boards are intended to be used with Shugart's SA1000 and 1100 8-in. and its SA600 5¼-in. drives, and match the dimensions of the drive hardware. Shugart's introduction of these SASI controller chips and boards comes shortly after Adaptec, Inc., a new company in Milpitas, Calif., unveiled similar products for OEMs (MMS, October, p. 284). Six generic commands are included with the SA1600s, which, when introduced into the host operating system, result in device independence to allow mass-storage peripherals to be changed without altering software or changing controllers. The four chips include an address chip, a sequencer chip, a data-recovery device for data separation and a data-recovery device for digitizing analog signals. The SA1601 for 8-in. drives sells for $325 in quantities of 50; the SA1610 for 5¼-in. drives sells for $300 in similar quantities. Evaluation units of the controllers will be available during the first quarter of 1983. Shugart plans controllers to handle combinations of floppy and rigid disk drives for later next year.

TELEVIDEO TO SHOW 15 NEW SYSTEMS PRODUCTS AT COMDEX

TeleVideo Systems, Inc., which recently closed its first year as a computer vendor with an impressive $60 million in sales, plans a barrage of 15 new microcomputer products at Comdex this month. The 8- and 16-bit systems, packaged in the recently introduced 970 terminal shell, will be offered in base configurations using half-height floppies and priced $500 less than comparable 802 and 1602 models in the existing line. The system that could lead the parade, however, might not be ready in time for Comdex. That model, based on the Motorola MC68000, will mark TeleVideo's entry into the UNIX systems market, and will reportedly be competitively priced with Fortune Systems' 32:16.

Controllers and Subsystems with No Service Is Only Half a Deal.

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Breakpoints

DATAPRINTER BAND PRINTER DUE NEXT YEAR

DataPrinter Corp., Malden, Mass., will introduce a family of band-train printers when the BT 1500 duty-cycle printer makes its debut in January. Based on an Intel 8080A microprocessor, the 132-character impact printer operates at 1500 lpm and offers a paper slew rate of 1016 mm. per sec. Bit-parallel and character-serial interfaces are standard. A key feature is the BT 1500's electronic character alignment, which allows a user to adjust and align characters using push buttons. The MTBF is 1000 hours at 60-percent duty cycles. The BT 1500 carries many of the same features as the company's current band-printer line, but a new hammer bank has been added to enhance print speed. The BT 1500, says product marketing specialist Paul Goldberg, is targeted to compete with the Data products Corp. BP1500 printer, and is intended for use in superminicomputer and high-reliability computer systems. Price is $17,000 in low OEM quantities, and single-unit price will be approximately $19,100.

START-UP TO ENTER VLSI DESIGN FRAY WITH UNIX-BASED WORKSTATION

There may be a shortage of electrical engineers, but there's no shortage of companies coming to their aid with computer-aided engineering workstations. One, San Jose start-up Cadtec Corp., plans early next year to introduce a UNIX-based, networking workstation with high-resolution color graphics that is designed to tie to a Digital Equipment Corp. VAX minicomputer running under VMS. Software for the workstation features logic simulation and an emphasis on management aids to control the interaction of large project teams working on complex VLSI designs. Hardware for the as-yet-unpriced system is being developed jointly with a company that Cadtec will not name. The software has a design goal of surpassing the performance of the Apollo Domain by incorporating a bit-slice graphics processor. Cadtec's system will stop short of physical IC design, interfacing to existing tools in that area.

PERTEC WILL UNVEIL FULLY INTEGRATED SYSTEM

Pertec Computer Corp. is expected to offer a fully integrated version of the Pertec 3000 multi-user microprocessor-based small-business computer system at Comdex. The basic configuration comprises a Motorola MC68000 16-bit CPU with 256K bytes of main memory, one 1.6M-byte, 8-in. floppy disk drive, one 26M-byte Winchester drive, a 21M-byte streaming cartridge tape, two CRT terminals and one printer. The basic configuration, at a single-unit price of $17,500, can be expanded to include a combination of as many as 19 CRT terminals, workstations or printers, at a high-end price of $100,000, with OEM discounts of 30 to 45 percent available, according to the company. Pertec has installed the system in approximately 20 sites so far and has received an OEM contract from 3M Co., which interfaces the systems to its own microfilm equipment. Pertec is delivering 30 to 40 systems per month to 3M, which puts the Scotch Brand label on the hardware, Pertec sources say.

PRECISION TO RELEASE PANEL-DRIVEN PRESENTATION GRAPHICS PACKAGE

Sophisticated end users and OEMs can use Precision Visual Inc.'s new Grafmaster software package and a proprietary menu-definition language/compiler to tailor menu-driven presentation graphics systems for a site, firm or industry. Grafmaster's menus are formatted VDT images; going through menus, a user can accept default values or choose new ones to define graphs and charts. The menu-definition language allows an OEM to choose the level of detail appropriate for the user and to create menus using terminology associated with an application. Written on top of the Boulder, Colo., company's Core-based, device-independent graphics software, Grafmaster drives 40 output devices and will be available in February, 1983, for use with the Digital Equipment Corp. VAX minicomputer. Price for a single license is $18,000; pricing on the menu-definition compiler is not yet set.

TECH FILES: A QUICK LOOK AT INDUSTRY DEVELOPMENTS

Terminal files: Independent manufacturers of lower priced emulating terminals beware: The big boys want some of their terminal market back and think they know how to get it. The warning comes from a **Dataquest** study on data terminals, scheduled for December release, which says several large computer manufacturers are embedding firmware in forthcoming terminals that works with proprietary firmware on the host to ease the user interface. The study says that although terminals from

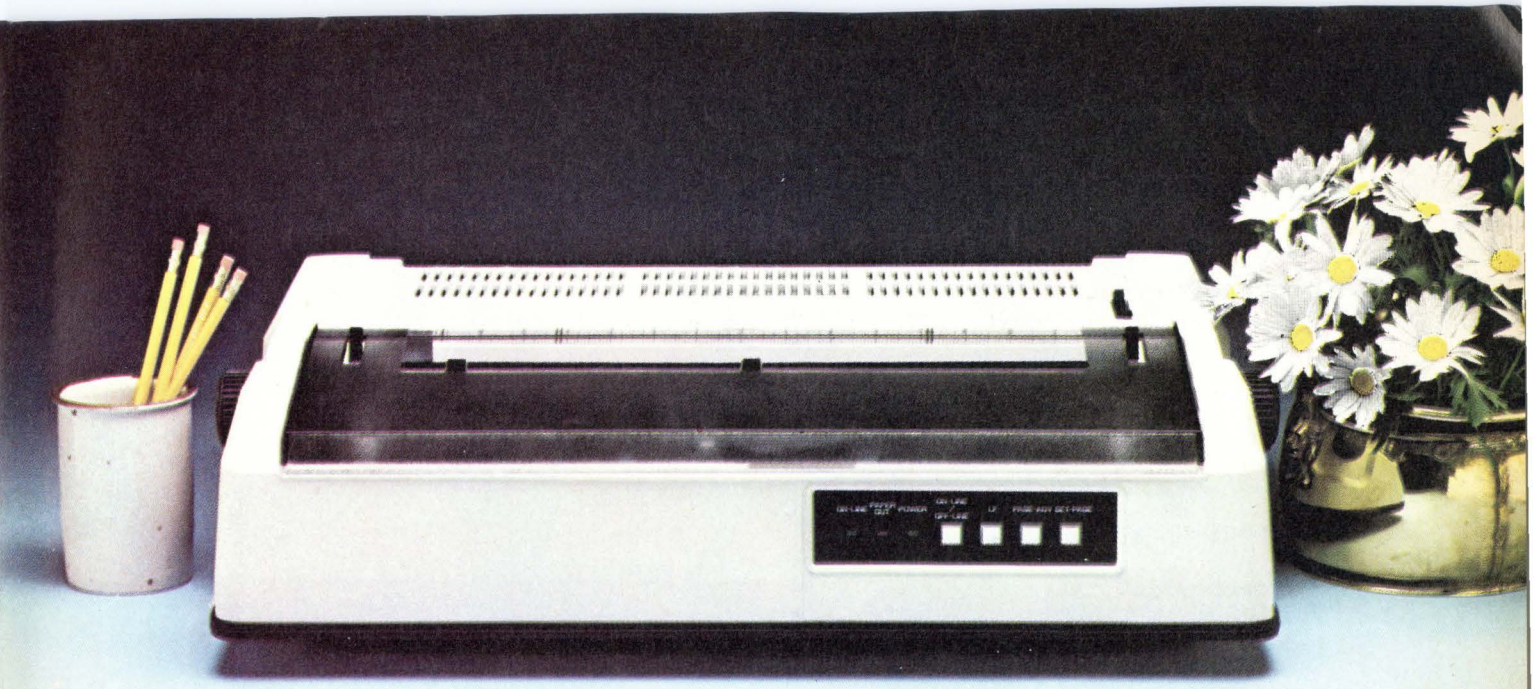
independent manufacturers will still work with those hosts, the independents will have to clear tricky trade-secret hurdles to emulate the new terminal user interfaces fully. . . . Printer manufacturer **Qume Corp.** is expected to move into the VDT business at Comdex, with a family anchored by an editing unit that lists for $695.

Mini files: Hewlett-Packard Co. is expected to introduce its long-awaited 32-bit computer this month. Reportedly called the HP9000, the system is based on the Palo Alto, Calif., company's 32-bit NMOS chip set, introduced over the last two years at International Solid State Circuits Conference meetings. The 9000 will open a new family of systems from HP. . . . SIBOL, a run-time system and compiler that enables DIBOL source code from a **Digitial Equipment Corp.** computer to be run on any 16-bit microcomputer supporting UNIX, will make its U.S. debut at Comdex. SIBOL was developed by Software Ireland, Belfast, which plans to sell it in the U.S. through distributors of DEC software.

Printer files: Coming at Comdex: **NEC Information Systems, Inc.,** will show its Spinwriter 2000 Series 20-cps, bidirectional, letter-quality printer. The 2000 will use the same Spinwriter 128-character thimble as the company's current line and is equipped with serial and parallel interfaces. The company says the 2000 will offer letter-quality and simple graphics capabilities to low-end users. The 2000, which uses a linear stepper motor, will sell for about $1500 retail, and OEM pricing will be less than $1000. Production quantities are slated for December. . . . **C. Itoh** will show its model 8600 18-wire, single-pass, dot-matrix printer that runs at 90 cps in near-letter-quality mode, and 180 cps in data-processing mode. The company says the printer achieves a 240- x 120-dpi addressable graphics resolution. C. Itoh officials aren't sure how they will ultimately sell the printer, but large OEMs are the initial market. Production quantities of the 8600 will begin before year-end. Single-unit pricing will be less than $1500. OEM discounts are available, but the company does not release specific figures. . . .

Micro Files: Wicat Systems is expanding its family of MC68000-based systems, with the first rack-mounted version aimed at system integrators, expected to surface at Comdex. Based on the under-desk-enclosed System 100 (Wicat's first product), the System 200 supports as many as 32 users. A second system, based on the desk-top 150 architecture, is dubbed the 160 and includes a 20-slot Multibus chassis . . . . Fellow MC68000 system builder **Callan Data Systems** also will upgrade its line of UNIX-based Unistar systems at Comdex. Callan is expected to demonstrate an Ethernet connection on a Multibus card . . . . **Digital Research, Inc.,** will write a version of its 16-bit CP/M operating system for Zilog, Inc.'s Z8000 CPU. The companies also will configure the software for Zilog's Z800 8-/16-bit Z80 follow-on, and for the company's 32-bit device, the Z80000. CP/M for the Z8000 is expected to be ready by the first quarter of 1983 . . . . A multi-user MUMPS environment for the Digital Equipment Corp. Professional 325 and 350 personal computers is provided by the standard MUMPS Micromachine operating system. SMM will be sold in the U.S. by **Computer Technology, Inc.,** Memphis, which now sells a PDP-11 version of the system. SMM originates from Structured Data Systems of Newtown Stewart, Wigtownshire, Scotland. The version for DEC personal machines will offer a multi-user alternative to the DSM single-user version of DEC standard MUMPS, which is expected from DEC for the 325 and 350. The Scottish company is also preparing a version of SMM for the IBM Corp. Series/1 minicomputer.

Random disk files: Seagate Technology, Scotts Valley, Calif., will introduce its first half-height, 5¼-in. Winchester disk drive at Comdex. The 6.38M-byte ST-206 is a 1.65-in.-high version of Seagate's ST-406 hardware. Prices have not been set, but evaluation units of the drive will be ready by the first quarter of 1983, and volume production will begin in the second quarter . . . . **Information Systems, Inc.,** has reportedly delivered several 402M-byte, 8-in. Winchester disk drives to Nippon Telephone & Telegraph in Japan. Called the JS4380, the drive uses thin-film heads and media and has an access time of 18 msec. and a transfer rate of 1.344M bps. Configurations delivered to NTT include eight drives per cabinet for a total of 3.2G bytes. An NEC source says the company is considering bringing the hardware to the U.S., but is constrained by the product's cost and interface requirements. A U.S. introduction could not happen sooner than late 1984.



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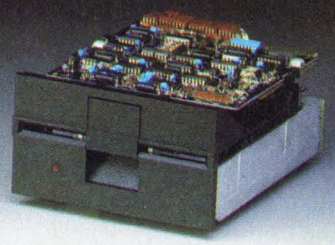

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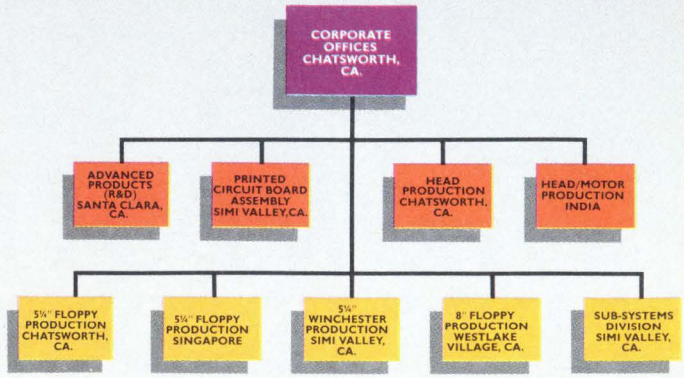

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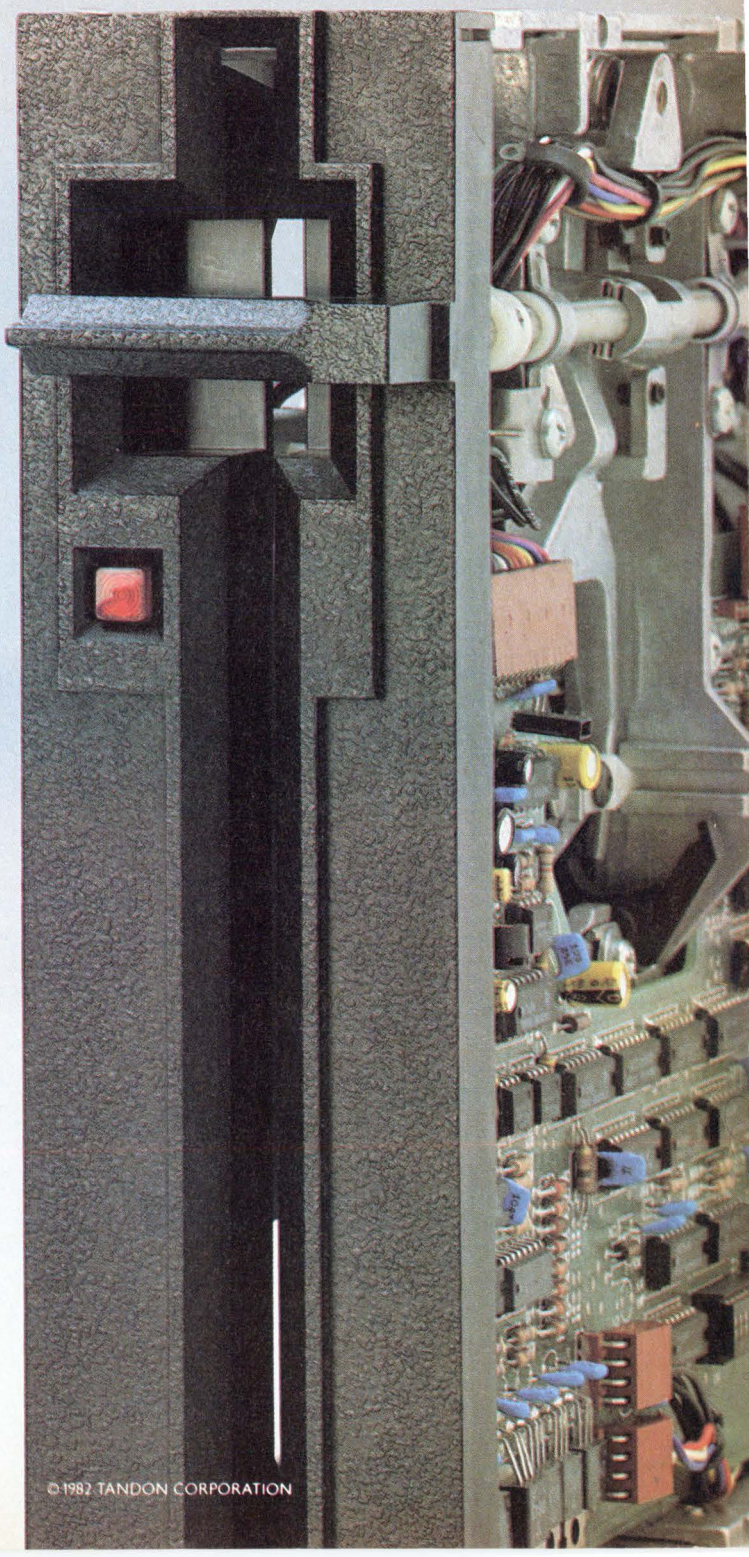

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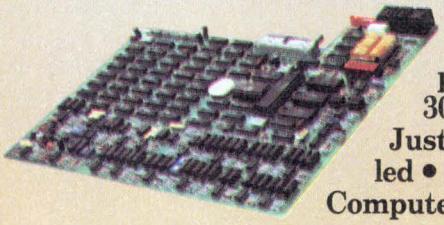

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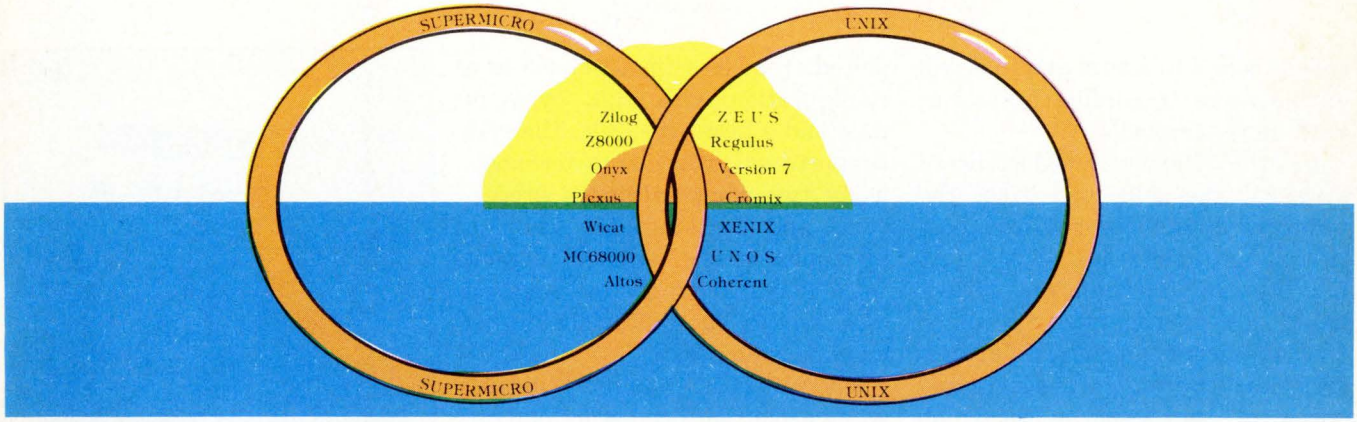


UNIX and the supermicrocomputer: a marriage of convenience

They weren't exactly "made for each other," but Western Electric's UNIX operating system and an emerging generation of high-powered microcomputers are marching down the aisle in a marriage of convenience that is being celebrated at microcomputer companies throughout the industry.

What started as a trickle more than two years ago with products such as Onyx Systems Inc.'s Z8000-based 8002 has turned into a torrent in the year since Western Electric released its System III update and decreased licensing fees to make UNIX more attractive to microcomputer vendors. What has emerged is a plethora of high-performance, 16-bit microcomputers—dominated by the Motorola MC68000, but including the Z8000—that promises to challenge traditional minicomputers and some 32-bit superminicomputers as well in the OEM systems market. Although a standard UNIX has not emerged, (see "UNIX and look-alikes reaching crossroads," p. 18), many of the new computers use UNIX System III.

One measure of the flood of UNIX-based supermicrocomputers are the nearly 30 companies that have announced products, according to an informal count by Jean Yates. Yates, whose Los Altos, Calif.-based Yates Ventures offers consulting services including market studies and software evaluations to companies entering the UNIX market, says she knows of 256 companies actively marketing UNIX-based systems (minicomputers and microcomputers), software and services. She says the number of application programs available—what many observers consider a sticking point in UNIX's growth—has swollen to 400, twice what was available a year ago. She cautions, however, that many of those products are little more than a "glimmer in someone's eye."

A year ago when Yates predicted that UNIX hardware, software and services would be a $6-billion market in 1986, her projections were scorned. This year, she says that number is considered conservative, especially in light of ever-increasing product introductions.

Plexus Computers, Inc., an early entrant into the supermicro/UNIX market in mid-1981, this month is planning to introduce two models that use an MC68000 instead of a Zilog Z8000. They will initially use the 12.5-MHz Motorola part, but are designed to accept the forthcoming 68010 version that will support a virtual-memory implementation of UNIX System III. The result, Plexus officials claim, will be a supermicrocomputer that is expected to offer performance in the range of a DEC VAX-11/780.

In moving to the Motorola chip, the company is not simply responding to the torrent of MC68000-based systems that have appeared in the past year, says Plexus product marketing manager James F. Groff. Groff maintains that the Plexus design, which links as many as eight independent processors along a Multibus, and Plexus's "distributed UNIX" implementation "leapfrogs" other MC68000 designs. Company president Robert Marsh claims that many MC68000 implementations are single-board designs that use ROM-based I/O controllers, and consequently do not take advantage of the MC68000's speed.

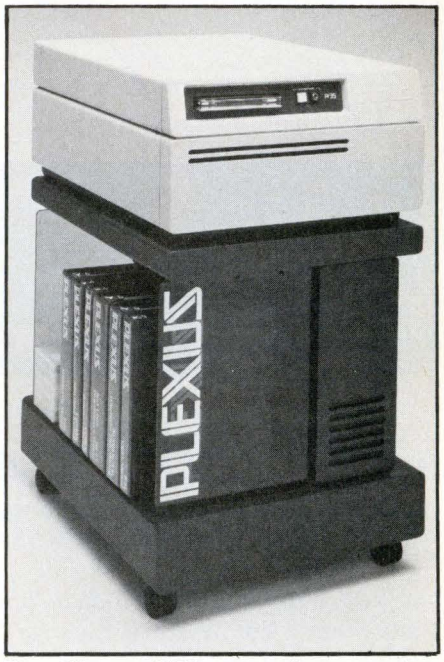
Groff also says that the adoption of the Motorola chip does not obsolete Plexus's Z8000-based products. When the MC68000 versions are introduced, Plexus also plans to unveil new versions of the Z8000 products that use a new memory-management scheme to increase

speed from 4 to 5 MHz and that will enable users to configure systems with more terminals.

In the Plexus MC68000-based systems, the P/35 and P/60, the company essentially replaced only the Z8000-based job processor, leaving the independent Z8000-based disk-management, terminal and data-communications processors intact. Because of the increased speed of the MC68000-based job processor, however, the system is expected to run four to five times faster than the Z8000 versions.

The P/35 is a follow-on to the desk-top P/25, which Plexus introduced this year. The P/35 is housed in a free-standing, desk-high enclosure with one 8-in. Winchester disk drive and a cartridge-tape drive in its base, which also doubles as a bookcase for manuals. The P/25 is priced from less than $40,000 in a configuration with 512K bytes of RAM and a 22M-byte disk. The P/35 supports as many as 16 terminals using two communications processors and is available with a maximum of 2M bytes of 64K-bit RAM. A maximum of 216M bytes of disk storage can be attached using an expansion box.

The P/60 is essentially a P/40 with an MC68000 job processor, but can be expanded with seven intelligent processor boards instead of the five supported on the P/40. As a result, users can attach as many as 40 local terminals to the system. Packaged in a free-standing, full-sized cabinet, the P/60 has a base configuration with 512K bytes of RAM and 72M bytes of 14-in. Winchester disk priced at less than $60,000. Main memory is expandable to 4M bytes.



The Plexus P/35 supermicrocomputer, *which is MC68000-based and runs UNIX Systems III, can host as many as 16 users.*

UNIX AND LOOK-ALIKES REACHING CROSSROADS

UNIX is UNIX is UNIX, right? Not exactly. Besides the "official" versions —Bell Laboratories version 7 and System III—there are the "look-alikes," such as UNOX, ZEUS and Coherent. These implementations of the operating system run on various minicomputers and microprocessor-based systems and have the elements to make business application software work.

While the differences between these implementations and standard UNIX are not vast, they are annoying, says Robert Marsh, president of Plexus Computers, Inc., Santa Clara, Calif. "For the most part, the differences are small," he says. "But they do have an impact, especially in areas such as terminal I/O," the "shell" portion of the operating systems.

Marsh, however, thinks that for UNIX to catch on as a standard, such differences should not exist. "We don't want [these changes]; there's no reason for them." He adds that it is in a vendor's best interest to remain compatible with a standard UNIX such as System III if the vendor expects application software companies to adopt the operating system, one important aspect of UNIX's success.

A standards committee, spearheaded by /usr/group, a UNIX users' organization begun by Marsh, is working on a standard based on System III. A draft is being readied for a January meeting, and Marsh thinks a standard based on System III will emerge. "Once a standard is defined," he says, "even those with UNIX look-alikes will come into line."

A big question still remains: what does AT&T intend to do? Although the company introduced System III as a commercial product, bringing its license fees to a price that would help sales of the operating system, an overall effort by AT&T is severely lacking.

"Unless Bell makes a definitive move to support System III," says Jean Yates, president of Yates Ventures, Los Altos, Calif., "most systems will be running UNIX look-alikes or nonlicensed UNIX." She adds that Bell must support UNIX by helping porting, providing telephone service and documentation. Most important, though, is a "cohesive upgrade policy," she says. If Bell does not provide support, she asks, what's the advantage [to an OEM] of staying with licensed UNIX?

Yates estimates that, by the end of next year, about 60,000 UNIX licenses could be sold. She compares that with 50,000 UNIX look-alikes. Those figures could change radically, with look-alikes nearly doubling in number while licensed versions decline, if no support from Bell is forthcoming. This could hurt system builders counting on application-software growth. Further, doing business with AT&T can't hurt an OEM's image, she says.

"AT&T has just a few months to make a clear-cut move with UNIX, or it will lose the market almost totally," Yates says. "UNIX will become a generic term for portability rather than a solid product."

—Larry Lettieri

The Plexus MC68000 implementation features a single-board job processor with a potential 16M-byte physical address space (limited to 4M bytes in the current 64K RAM system), a memory-management system with a 4096-page (4K pages) memory map and a 4K-byte, high-speed cache memory with a 32-bit path to main memory and a DMA path to the Multibus. Memory access can be as fast as 45 nsec. with a cache hit on the first attempt. Access would normally average 150 to 200 nsec., Groff says.

Plexus has designed the MC68000 job processor to accept the forthcoming 68010 chip, which will allow mid-cycle interrupts and, therefore, support virtual-memory implementation of UNIX System III. The company does not speculate about when its virtual-memory version will be available because it does not know when 68010 chips will be shipped, a spokeswoman explains. However, Plexus uses preproduction versions of the chip to write the virtual-memory software.

The ACS68000 microcomputer from Altos *runs UNIX System III and other operating systems. The MC68000-based product accommodates as many as 16 users.*

Altos Computer Systems, Inc., which launched its first 16-bit microcomputer using an Intel 8086 a year ago, has recently announced the first in a planned series of products that will use the MC68000. Company president David Jackson explains that the move to the Motorola chip does not signal a retreat from the 8086, but is an expansion into OEM markets. The company will continue to support its 8086 systems and plans additional 8086-based products, which are considered more attractive to computer retailers and dealers, which still account for 60 percent of Altos's revenues.

Altos's MC68000 implementation, designated the ACS68000 will include a range of available operating systems. For the UNIX base, the system has UNIX System III and will

Representative supermicros with UNIX or UNIX-like operating systems

Company	Product(s)	Processor(s)	Operating system
Alcyon Corp.	AWX workstation, APX 16-user system	10-MHz MC68000, 2 MC6441s	Regulus (UNIX System III-call compatible)
Altos Computer Systems, Inc.	ACS68000 family (multiuser)	8-MHz MC68000 memory mgt. chip with 4 68451 memory mgt. processors	UNIX System III, RM/COS operating system (Ryan McFarland)
Callan Data Systems	Unistar 100 workstation	MC68000	UNIX Version 7
Charles River Data Systems, Inc.	Universe 68 line (68/05, 68/37, 68/47, 68/80)	12.5-MHz MC68000	UNOS (UNIX-like)
Codata Corp.	CTW 300	MC68000	UNIX Version 7
CIE Systems, Inc.	CIES 680 family; 680/10 (single user), 680/40 (16 user)	MC68000	UNIX System III
Computhink	HAWK-32, HAWK-32E	MC68000	UNIX Version 7, UNOS (CRDS)
Cosmos Systems, Inc.	CM516/UNIX System, Oral 68000-based Multibus, XENIX or UNIX	MC68000	UNIX Version 7, System III
Cromemco, Inc.	System One, System Two, System Three	All versions have MC68000 and Z80A	Cromix O/S (UNIX-like)
Cyb Systems, Inc.	Multibox System	MC68000	UNIX Version 7
Dual Systems Control Corp.	System 83 family	8-MHz MC68000	UNIX Version 7 (Unisoft)
Fortune Systems	Fortune 32:16	MC68000	UNIX Version 7
Forward Technology, Inc.	Forward Gateway workstation	MC68000	XENIX (Microsoft)
Intellimac, Inc.	IN/7000 (M,KF,KL)	MC68000	UNIX Version 7 (Unisoft, Berkeley enhancement), ROS (ADA)
Ithaca Intersystems	8000/510, 8000/810	Z8002 (with memory management)	Coherent (UNIX-like)
Masscomp	MC-500	2 10-MHz MC68000	UNIX System III
Onyx	8002 (8 user), Sundance (5 user)	Z8000, Z8000	UNIX System III, UNIX System III
Plexus	P/25/35/40/60	MC68000 (/35,/60), Z8000 (/25,/40)	UNIX System III
Wicat Systems, Inc.	System 100 (1-32 users), System 150 (1-6 users)	MC68000, MC68000	UNIX System III, UNIX System III
Zilog, Inc.	System 8000 family	Z8000	Zeus (UNIX-like)

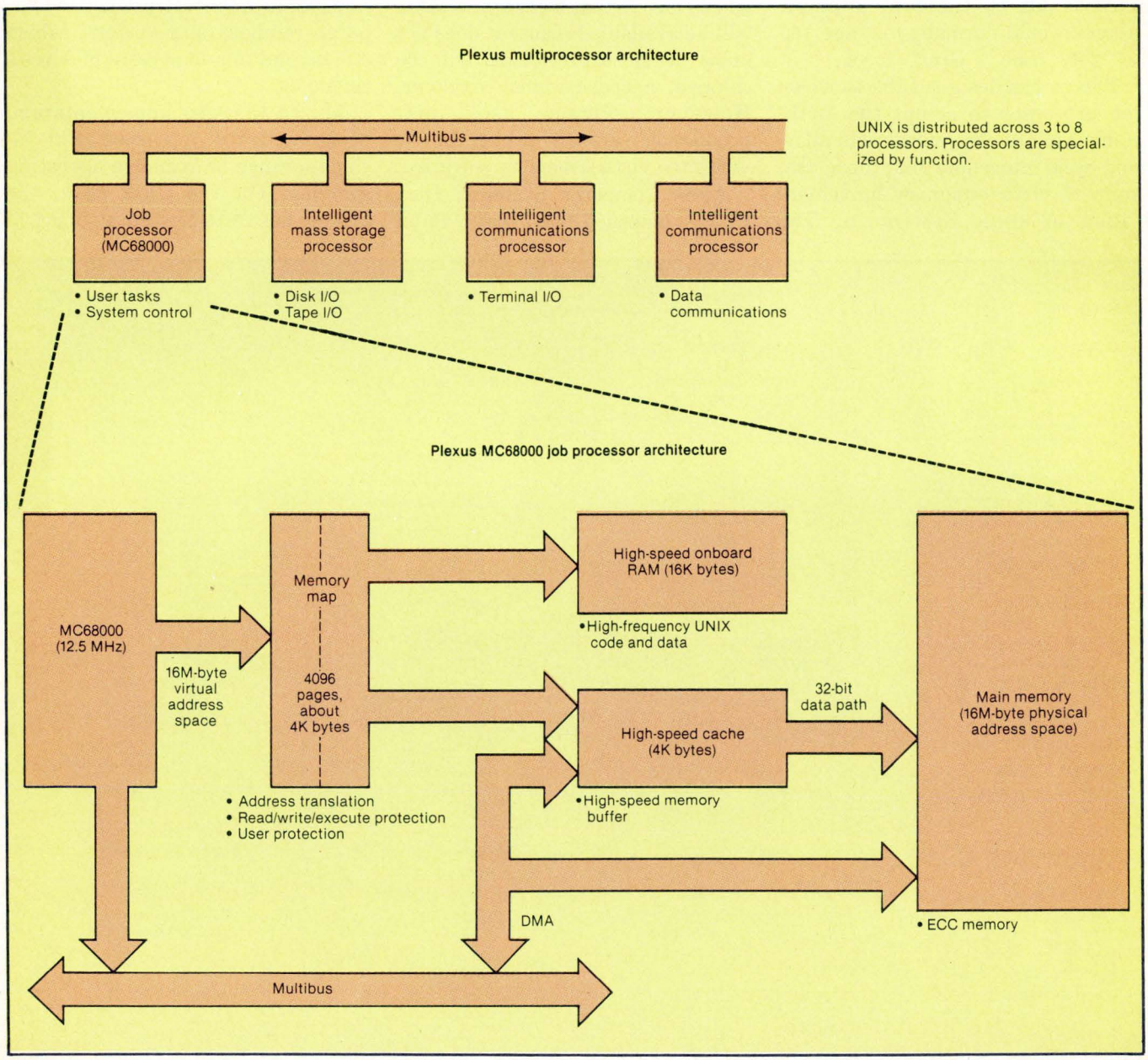
include portions of the 4.1 BSD from Berkeley Software Distribution and an Altos-developed menu-driven user shell.

The Altos implementation uses an 8-MHz MC68000 and four 68451 memory-management chips to supervise a cache memory. The system uses Z80-based intelligent I/O controllers supporting as many as 16 RS232 channels as well as an RS422 interface to the company's Altos-net local-area network. A Multibus-expansion chassis can be added to support a maximum of 16M bytes of main memory and expansion peripherals including SMD interface disks and nine-track tape drives.

The system supports as many as 16 users and is available in 40M- and 80M-byte disk versions starting at $14,500 and $16,500, respectively, and available early next year.

Like Plexus, Altos also plans to implement a virtual-memory version of UNIX System III, which it expects to offer in the first quarter of 1983.

CIE Systems, the Irvine, Calif.-based subsidiary of C. Itoh Electronics, has fleshed out its line of MC68000-based systems with a mid-range 680/30 that uses 5¼-in. Winchester disks (MMS, October, p. 6), and a more standard UNIX



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implementation, UNIX System III. The 680/30 supports as many as eight users, and prices start at $8900 for a base configuration with 128K bytes of RAM, a communications controller with four serial ports and one parallel port, a 1.6M-byte floppy and a 10M-byte Winchester disk. In OEM quantities of 500 units, price drops to $5340 each.

The 680/30 has a nine-slot Multibus chassis and can be configured with 768K bytes of main memory, 40M bytes of Winchester disk, eight serial ports and two parallel ports.

Warren Blossom, vice president of marketing at CIE, says the 680/30 will appeal to OEMs that wish to market a less identifiable product. The 7-in.-high desk-top enclosure can be used in a standard 19-in. rack mount by removing two plastic side panels. Another OEM-oriented feature is a back panel that can be customized with pop-out panels for asynchronous communications, ribbon cables and DMA line-printer connections.

The 680/30 features a pop-up card cage so that boards can be inserted or swapped without disturbing the rear-mounted external connectors, Blossom points out.

Like the other CIE systems introduced this year, the 680/30 was designed in the U.S., but is manufactured in Japan by a consumer electronics division of Hitachi. The full line is due in the fourth quarter of this year, and all models are available with UNIX System III (starting in January), Alcyon Systems' Regulus (described as a UNIX superset) and Pro IV, a program generator.

General Automation, which signed a $50-million contract to buy MC68000-based systems from CIE, has been readying its own MC68000-based products for a fall introduction. The first model is said to be positioned close to CIE's 680/10, a low-end single-user system, but the GA machine may support as many as 16 users, says Donald A. Heitt, vice president of sales and marketing. The GA product is expected in January, but pricing and more specifications were not available at press time.

GA plans to offer UNIX System III on its machines and on the CIE systems in the spring and will offer its products with the Pick operating system and the Pro IV program generator. Heitt says the company plans to forego the UNIX-like Regulus operating system that CIE offers.

Heitt says that the CIE products and GA-developed MC68000 computers are the first that GA plans for expansion into commercial OEM markets from its established base in technical applications. The initial desk-top system will be followed in the first quarter of 1983 with a desk-high product. Both will be built around a Multibus architecture. Further down the road, Heitt says, GA plans to add an MC68000-based system to compete in the 32-bit superminicomputer market. That move will give the company a range of compatible products starting with a single-user desk-top system to a 32-bit minicomputer.

—Geoff Lewis

MOTOROLA LICENSES UNIX-LIKE REGULUS

Motorola, Inc., early this month licensed San Diego-based Alcyon Corp.'s UNIX-compatible operating system, REGULUS. The MC68000-hosted REGULUS software is claimed to run in less than two-thirds the memory required by Bell Laboratories' UNIX, yet offers command and system-call compatibility with UNIX V6, V7 and System III as well as a superset of UNIX capabilities that includes support for real-time processes, file/record locking and multi-keyed ISAM. Motorola and Alcyon have also entered a long-term technology-transfer agreement to enhance REGULUS with graphics and network support and an integral database-management system.

IBM-compatible portables offer smaller footprints

The wide trail blazed by IBM Corp.'s Personal Computer since its introduction last year cleared the way for many look-alike, add-on and compatible products, the most recent of which offers a smaller footprint for the mobile professionals at whom they are aimed.

Two firms—portable terminal manufacturer Computer Devices, Inc., Burlington, Mass., and start-up COMPAQ Computer Corp., Houston—introduced IBM PC-compatible portable computers within three weeks of each other. Both companies offer products that cram the functions of the IBM PC into a smaller, liftable package that at base $2995 prices undercut a comparably configured IBM PC by $500 to $600, depending on the IBM PC expansion memory board used. The first such product came from Dynalogic Info-Tech Corp., Ottawa, Canada, which introduced the Hyperion portable a few months ago (MMS, September, p. 64). All three products target the $1-billion market COMPAQ sees for hardware

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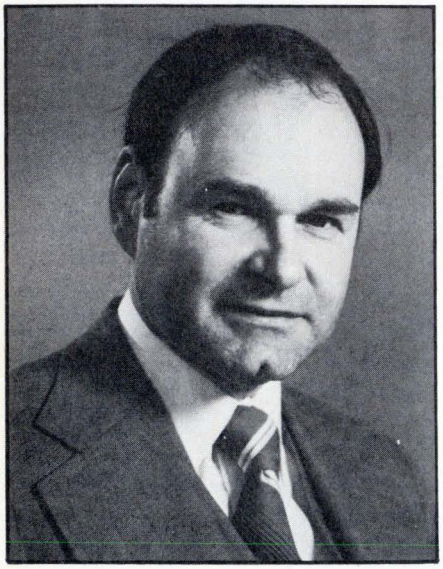
and software growing up around the IBM PC since 1981.

Seaforth Lyle, president of CDI, predicts a healthy market for portable computers. "About 10 percent of applications in the terminal business are portable," he says. He expects a similar ratio for IBM PC-compatible portable computers, which are convenient for professionals on the move. "What happens at 6 p.m. on a Friday when a professional must continue working, but can't take a desk-top IBM PC home?" asks Rod Canion, president and one of three founders of COMPAQ. With his company's portable computer, also called COMPAQ, a professional need own only one computer, which can be carried to and from the office. A user could purchase two IBM PCs or an IBM PC and a portable unit, but at double the expense, he notes.

The portable units weigh about half as much as an IBM PC. "Our equivalent monitor, keyboard and base unit weigh 28 lbs., while a similar IBM PC weighs about 50 lbs.," says William Murto, also a COMPAQ founder, serving as vice

Continued on page 30



Computer Devices, Inc., president Seaforth Lyle *says 10 percent of terminal applications are portable, and predicts a similar ratio for IBM PC-compatible portable computers.*

COMPAQ Computer Corp.'s founders *(left to right), Ron Canion, president, James Harris, vice president of engineering, and William Murto, vice president of marketing and sales, raised $10 million in venture-capital moneys and will launch an IBM PC-compatible portable computer bearing the company's name.*

IBM PC VS. COMPATIBLE PORTABLES

Company, product	IBM Corp. Personal Computer	Computer Devices, Inc. DOT	COMPAQ Computer Corp. COMPAQ	Dynalogic Info-Tech Corp. Hyperion
Physical size (w. × h. × d.)	20 × 16.5 × 16 in. (system box and monitor) 48 lb. (with keyboard)	17 × 8 × 13 in. 25 lb.	20 × 8.5 × 15.3 in. 28 lb.	18 × 8.5 × 10 in. 20 lb.
Processor, main memory	8088, 64K bytes ($350 to get 128K bytes)	8088, $250 for 32K bytes ($300 for 64K-byte additions)	8088, 128K bytes	8088, 256K bytes
Display	640 × 200 dot 11½ in. (monochrome)	640 × 200 and 1024 × 248 dot 5 × 9 in. (h. × w.)	640 × 200 dot 9 in.	640 × 250 dot 7 in.
Keyboard	83 keys (function keys clustered to right)	90 keys (function keys horizontal across top row)	IBM-like (function keys clustered to right)	84 keys (function keys horizontal across top row)
Peripherals	320K-byte, 5¼-in. floppy drive	287K-byte, 3½-in. floppy drive (internal printer can be added)	320K-byte, 5¼-in. floppy drive	640K-byte, dual 5¼-in. floppy drives
Operating system	PC DOS	MS/DOS or CP/M	MS/DOS	MS/DOS
Price, availability	$3125 now	$2995 (with 90-day warranty) January	$2995 January	$4995 (with built-in 300-bps modem) January

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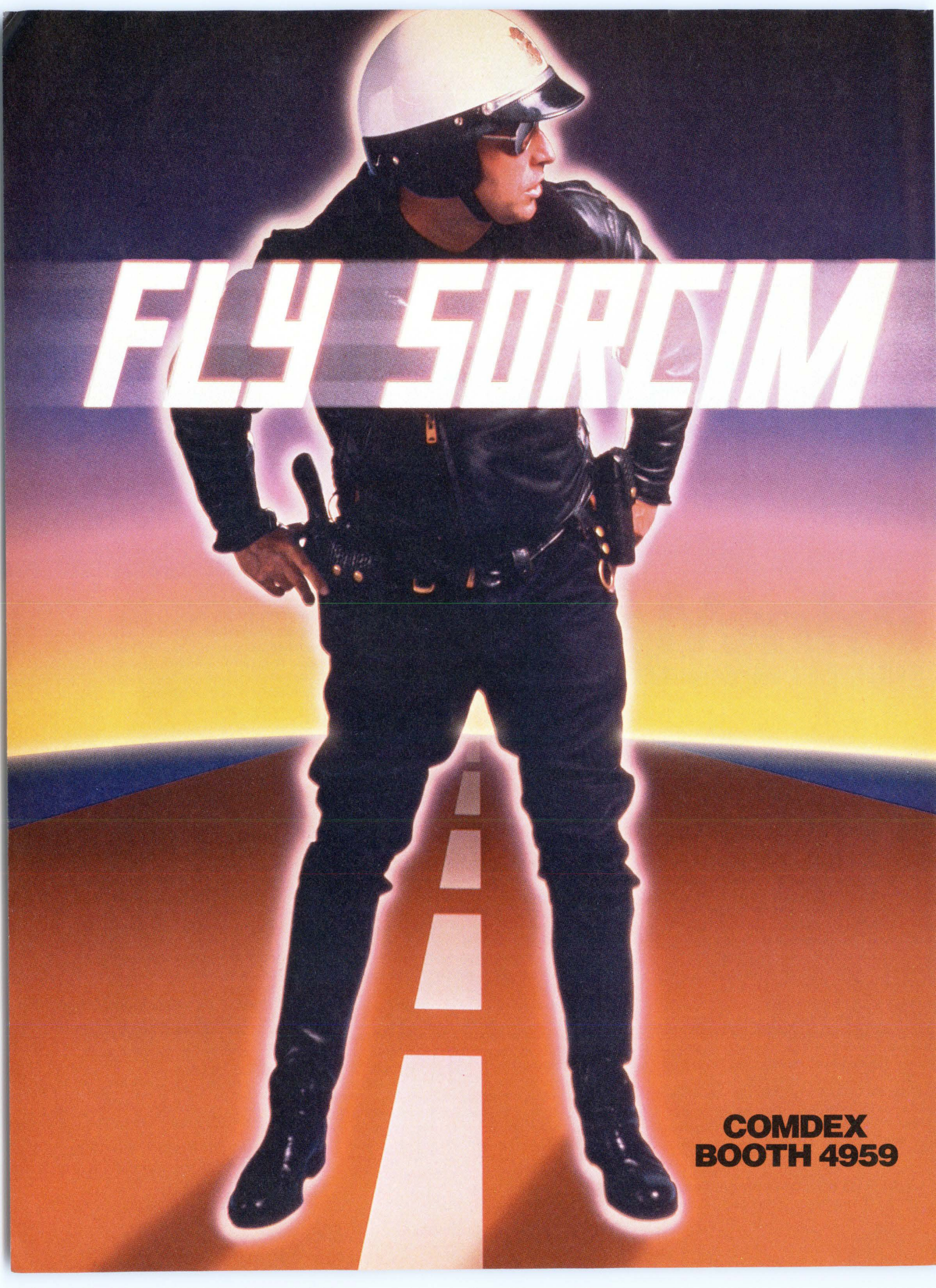
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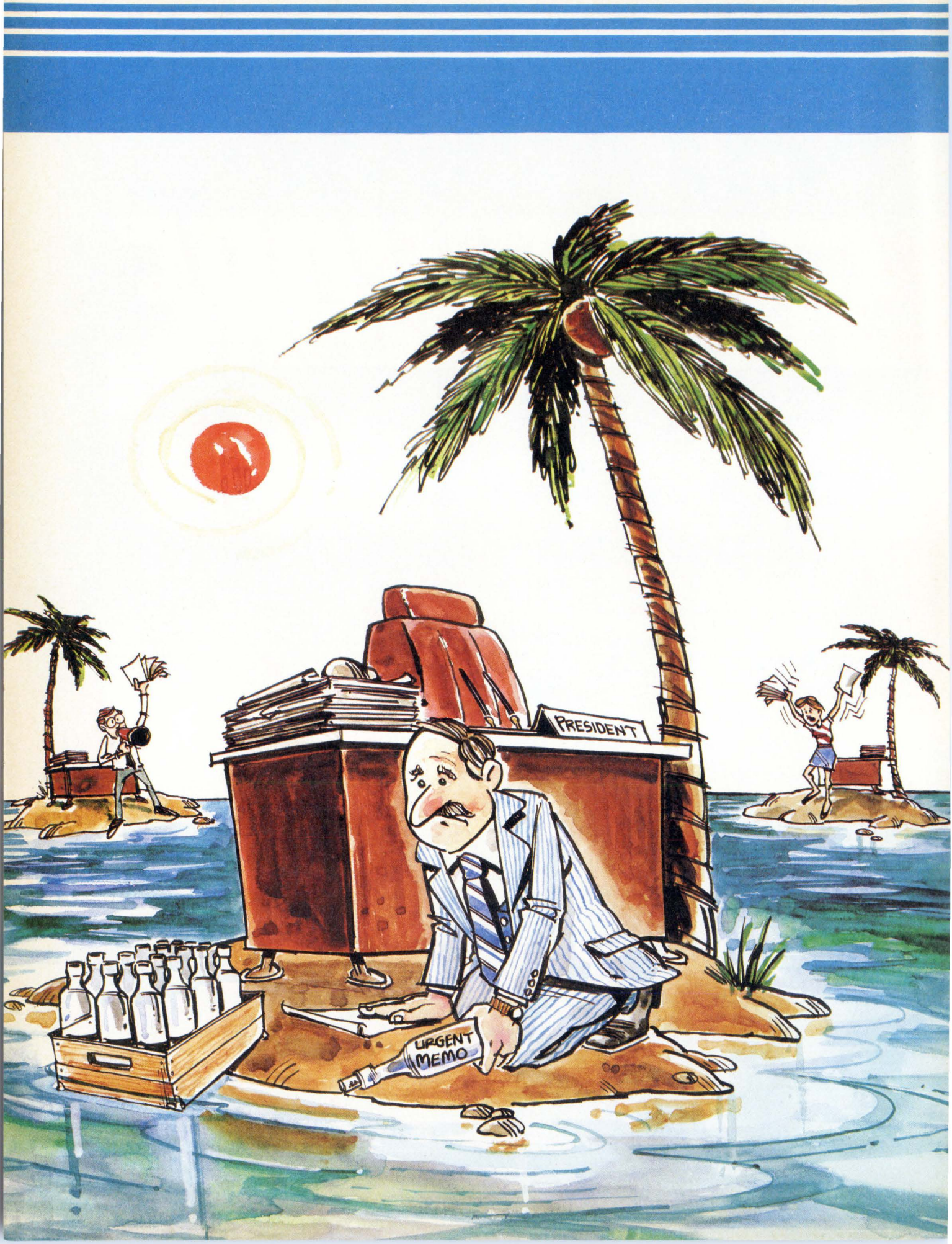
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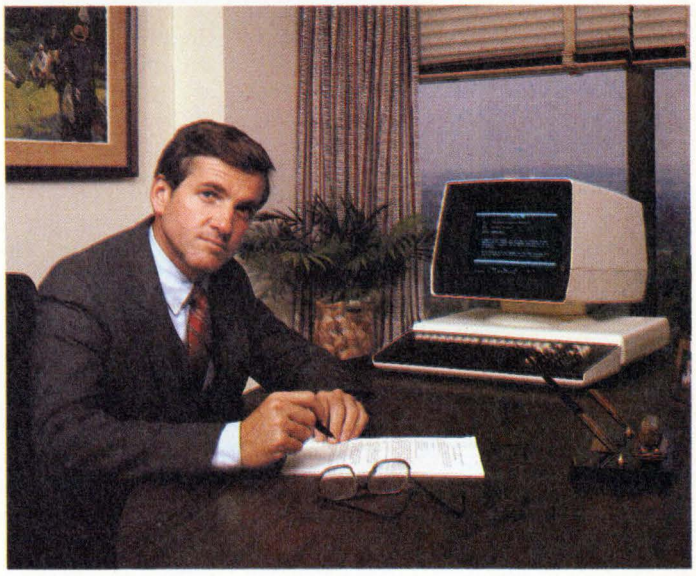

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CIRCLE NO. 17 ON INQUIRY CARD

Continued from page 24

president of marketing and sales. He notes that 28 lbs. is not as light as he desires. IBM specifications list the PC with a monitor, a keyboard and a system unit with one floppy drive at 48 lbs., while the system unit alone weighs 25 lbs. CDI's DOT portable weighs 25 lbs.

The COMPAQ measures 20 × 8.5 × 15.3 in (width × height × depth). CDI's DOT is 17 × 8 × 13 in. Comparably, the IBM PC system unit box with a display mounted on it and without a keyboard measures about 20 × 16.5 × 16 in. The portables' tight packaging creates unique design challenges for cooling, power and minimizing interference between peripherals (see "Compact portables pose unique design challenges," p. 33).

Hardware for a basic COMPAQ includes a 9-in. bit-mapped display with 640- × 200-dot resolution, one Control Data Corp. 320K-byte minifloppy and an IBM look-alike detachable keyboard (see "Compatibility: what does it mean?" p. 30). The device has an RGB, composite video, television (through an RF monitor), parallel printer ports and an optional serial port, but does not include a printer. An asynchronous interface is optional. Forthcoming options include internal modems and a local-area network connector, which will probably connect to the Corvus Omninet.

COMPATIBILITY: WHAT DOES IT MEAN?

"'Compatible' has a very strict definition in our terminology," says Rod Canion, president of COMPAQ Computer Corp., Houston, which this month introduces its first product, an IBM PC-compatible portable computer. "To us, it means software off the shelf can be run without modification."

That's why COMPAQ chose to replicate the IBM Personal Computer, which is becoming a standard in some Fortune 1000 companies, rather than improve on it. He says his company did improve on some characteristics, such as the display. "IBM offers two good capabilities, but not on the display," he says. Canion says IBM's monochrome display has excellent clarity, but no graphics, while its graphics board has good color and resolution, but poor alphanumeric characters that are inadequate for a spread sheet. To get graphics and high-resolution alphanumerics on the IBM PC, users need two adapters and two monitors, an IBM spokesman says.

COMPAQ uses a 25-line × 80-character green phosphor display that has high-resolution alphanumerics and graphics on the same screen. This is all on one board. A monitor with IBM color is an external COMPAQ option.

Another company with an IBM PC-compatible product is Dynalogic Info-Tech Corp. Although its Hyperion computer runs MS/DOS, some observers have criticized the company for forsaking compatibility for some software, such as VisiCalc, by improving the screen to display 640 × 250 dots rather than the 640 × 200 dots on the IBM PC. "VisiCalc can't be run on the Hyperion because the IBM PC VisiCalc addresses that hardware directly and not through the PC DOS operating system," says Kathryn Miller, Dynalogic customer support representative. She adds that VisiCalc can be translated into a data-interchange format file available with a VisiCalc package. The Hyperion's Multiplan spread-sheet package can read that file. However, Multiplan cannot be reverse-translated, she says. Additionally, the Hyperion has no expansion slots, but a four-slot IBM-compatible expansion chassis is planned for late next year.

While the Hyperion has function keys that parallel its display, the COMPAQ keyboard is an IBM PC look-alike, with function keys clustered on the right of the keyboard. Thus, users can follow IBM PC software manuals. Like keyboards are important so that professionals switching between the IBM PC in an office and a COMPAQ at home can make an easy transition, says Ben Rosen, a partner in COMPAQ's lead investor Sevin Rosen Partners, Ltd., and publisher of the *Rosen Electronics Letter*. "It is probably better to place the function keys across the top keyboard row so they parallel the display's soft-key indicators, rather than to the right, as on the IBM PC. But it's tough for a user of both machines to make that keyboard transition."

Canion says the inside of the COMPAQ computer looks similar to the IBM PC, except for the location of the screws. The company considered using microfloppy drives, but opted to remain closely compatible with IBM's PC minifloppies.

Rosen emphasizes the need for total IBM PC compatibility for peripherals, software, function and looks. "There are a lot of ways to improve on the IBM design, but if you get caught in that trap, you lose compatibility," he says, adding that MS/DOS and an 8088 alone aren't enough.

Computer Devices, Inc., Burlington, Mass., chose microfloppy drives for its DOT portable computers, partially to save space. The company does not anticipate any major problems with that move because major software houses appear to be accepting the smaller floppy drives, says Seaforth Lyle, CDI president. Lyle says it is as easy to copy software onto a 3½-in. floppy diskette as onto a 5¼-in. diskette. Most CDI software will be Microsoft compatible, he says. CDI will distribute the software on 3½-in. diskettes, and hopes software houses will do the same.

But the immediate conversion is to make the IBM PC media compatible with the DOT. Lyle says CDI will sell an option enabling PC users to run 3½-in. media on the PC. That option, selling for $400 to $500, would be important if a user had IBM PCs and DOTs in one environment, or wanted to hard-wire them.

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If your operators need a stack of manuals and a degree in Computer Science to operate your terminals then, chances are, you haven't yet heard of the new Tandberg Data conversational terminal. The Tandberg terminal's efficient, "friendly" operating features increase productivity and ease the operator's workload while they enhance your distributed data processing capability.

As a full ANSI standard editing terminal, the Tandberg TDV 2220 allows virtually all functions to be performed locally as well as from the host. For maximum flexibility all functional characteristics are prompted from easily understood "English" menus and may be stored in non-volatile memory.

The TDV 2220 will operate in character, line or block mode. Up to eight pages of local memory can be recalled and amended by page or "window." Sixteen editing functions allow insertions, deletions and erasure of characters, fields, areas, lines or pages while protected and unprotected fields may be defined in ten variations for local checking. Navigation keys permit quick and easy set-up of even the most complex tabular forms and PUSH-keys implement data strings at the touch of one button.

Not only is the Tandberg the easiest terminal to use, it's also the only terminal in the world that meets the stringent 1985 German ergonomic standard—with tilt, swivel and height adjustments, an ultra-low profile, detachable keyboard, all non-reflective surfaces, an anti-reflex tube, et al. Your operators will cheer.

In addition to the advanced performance Model TDV 2220 terminal, the Tandberg TDV 2200 family includes models which emulate the DEC VT 100/VT 52, Datapoint 3600 and 8200, Data General 6053 and D 200, IBM 3101 and others. Firmware development tools and hardware building blocks are also available to the OEM who wants to develop a terminal with its own personality.

So why put up with a terminal headache? The "face" of your computer system that the user sees could be a Tandberg terminal. Call or write today for our new brochure.

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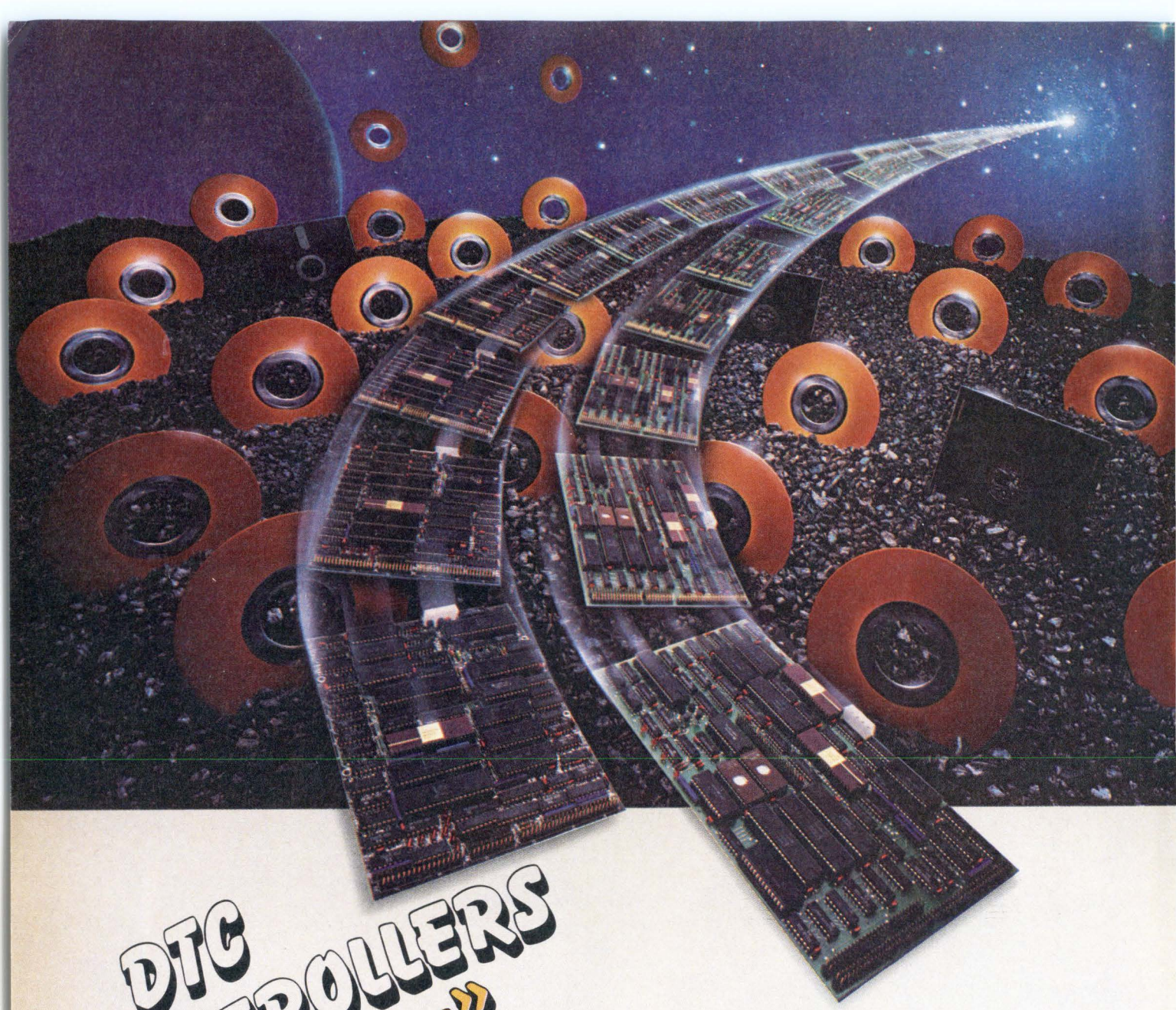

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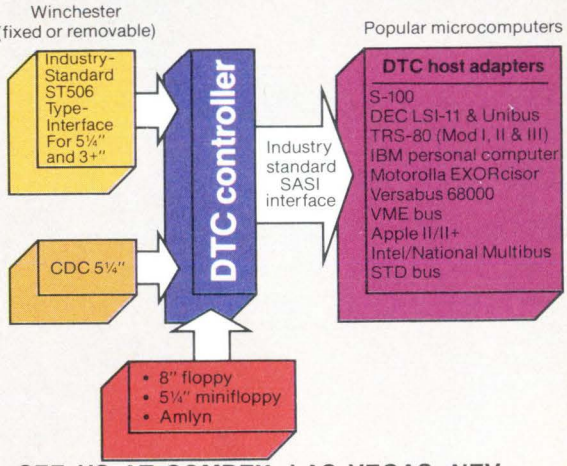

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CIRCLE NO. 22 ON INQUIRY CARD

DTC

Data Technology Corporation
2775 Northwestern Parkway
Santa Clara, California 95051
Telephone (408) 496-0434. TWX 919-338-2044
East Coast (617) 275-4044

CDI's four-member DOT family, in a base DOT I configuration includes a 5- × 9-in. Sanyo instrument quality display with bit-mapped graphics in selectable 640- × 200- or 1024- × 248-dot resolution and as many as 132 columns and 25 lines, one Sony 3½-in. microfloppy disk drive that stores 287K bytes per side, formatted, and a detachable keyboard. The CRT terminal and printer each have their own memory with 32K bytes of video RAM on a control board and 16K bytes of PROM and a 2K-byte buffer, respectively. An additional microfloppy drive can be housed internally, as can an 80- or 132-column selectable thermal CDI printer that accepts a full screen of CRT information.

Both the COMPAQ and DOT, like the IBM PC, include Intel 8088 microprocessors and run the MS/DOS operating system. The base 128K-byte COMPAQ system has five IBM-compatible expansion slots. Two slots are occupied, one by the video display board, and one by the floppy disk and printer port. Canion says the three empty slots should accommodate 90 percent of a user's needs. The IBM PC has five slots, with only one free for additions. The one slot free applies to an IBM PC configuration with 128K bytes of memory, monochrome alphanumeric and graphics/color displays, a keyboard, a floppy disk and PC DOS, an IBM spokesman says.

COMPAQ's 128K-byte RAM can be expanded to 256K bytes on the main system board. A second minifloppy drive is optional. The computer has a socket for an Intel 8087 math co-processor and an optional asynchronous interface. The system includes advanced BASIC, licensed from Microsoft, Inc. Third-party vendors can add CP/M-86 or p=

START-UP COMPAQ HAS PIECES IN PLACE

The era of "good idea," "garage shop" start-ups appears to be closing as new ventures surface with strong business and product plans in place.

COMPAQ Computer Corp., Houston, which enters the IBM PC-compatible market for portable computers this month with a product bearing its name, appears to have laid the appropriate groundwork for growth. Founded by three former Texas Instruments Inc. managers—COMPAQ president Rod Canion, vice president of engineering James W. Harris and vice president of marketing and sales William Murto—COMPAQ raised $10 million in venture funds in less than seven months. The initial $1.5-million infusion was led by venture-capitalist firm Sevin Rosen Partners, Ltd., Dallas. L.J. Sevin is a founder and former chairman of Mostek, Corp., and a former TI executive, and Ben Rosen is publisher of the *Rosen Electronics Letter.*

COMPAQ officials quote industry analysts' figures showing the personal-computer system market will grow from $2.3 billion this year to $8.3 billion in 1986. The IBM PC held less than a 5-percent market share this year, but will grow to more than 20 percent in 1986, according to COMPAQ information. Within one year, COMPAQ says, more than 3000 vendors will be selling IBM-compatible or related products. As for the portable-computer segment, Canion says, "The size of the market next year will surprise everyone."

The company is gearing up to handle potential large orders. It will use a computer-controlled materials-requirements-planning system to control production and lower costs in a 26,000-sq.-ft. manufacturing plant in Houston.

COMPACT PORTABLES POSE UNIQUE DESIGN CHALLENGES

Condensing the function of an IBM PC into a small portable package poses some unique design and durability challenges, especially with multiple peripherals housed internally.

"A lot of technology went into our packaging," notes Seaforth Lyle, president of Computer Devices, Inc., which recently released a portable IBM PC-compatible computer called the DOT. In the DOT, printer motors had to be placed near read/write heads and a high-voltage transformer. The CDI design had to limit electrical and acoustical interference between peripherals, and provide adequate cooling.

The company shielded certain peripherals from one another, and placed the shields to help conduct airflow from a small fan throughout the unit.

COMPAQ Computer Corp., which enters the market this month with a similar unit called COMPAQ, also uses a fan to cool its unit, which does not house an internal printer.

CDI's Lyle says the portable computers are not as rugged as CDI's portable terminals, mainly because of the glass CRT. COMPAQ also is concerned with durability, especially of disk drives. The floppy drives are shock mounted, and have rubber between them and the metal on the holding bracket in three dimensions. An additional packaging novelty is two external layers for the unit—the inner skin is metal to meet FCC RFI and EMI shielding requirements, and the outer is plastic for aesthetics. Durability is a sensitive issue when considering Winchester disks, which CDI may add to the DOT later. COMPAQ also is eyeing Winchesters but does not plan to add one this year. However, the COMPAQ's 120W power can handle a shock-mounted Winchester disk. Both the DOT and COMPAQ are being field-tested, so durability remains unproven.

system software.

The IBM PC, by comparison, holds 64K bytes of information on its motherboard and requires an extra board to expand to 128K bytes. A 64K-byte expansion board is priced at $350, while a $475, 64K-byte board can be expanded to 256K bytes in $200 64K memory module kit increments, an IBM spokesman says. COMPAQ can expand its motherboard to 256K bytes because the company used 64K-byte RAMs, Murto notes.

DOT's main memory board also handles as much as 256K bytes, expandable to 704K bytes via an expansion board. Memory is priced at about $300 for a 64K-byte increment. The product has four slots, two of which are free. The other two are occupied by one memory board with a 64K-byte minimum, and one bit-map graphics board. Card cages can be added through one of the free expansion slots. An 8087 math co-processor, coupled with a 488 bus, is optional. Both the DOT and COMPAQ accept any IBM-compatible boards.

In addition to the 8088, a Z80 board can be added to DOT to run CP/M-2.2 says CDI's Lyle. CP/M software also can be run by an emulator supported under MS/DOS. The DOT is available with the Z80 or the 8088, depending on the operating system. The two processors do not run together, Lyle says. CDI eventually plans to offer Multiplan BASIC, Pascal, FORTRAN, COBOL, C application generators and a relational database from third-party software houses.

The COMPAQ screen has 640- × 200-dot resolution, the same as IBM's monochrome display. CDI's DOT display is selectable at 640 × 200 dots or 1024 × 248 dots. Both the DOT and COMPAQ will have color display options, although COMPAQ's base configuration displays eight shades of green.

The high-end DOT IV, including an Intel 8088, 128K bytes of memory, a bit-mapped monitor, a keyboard, two slots, two microfloppy drives, a printer and a communications port, MS/DOS, GW BASIC (graphics with BASIC), asynchronous communications, software manuals, an integrated printer and controller, a 300-baud modem, 52 hours of time-sharing remote computer service time and a 90-day warranty, sells for $3997. CDI offers volume and OEM discounts for all four DOT models.

CDI's portable terminals are carried by 20 distributors, which CDI hopes to sign for the computer as well. The company also has a 20-person end-user sales force, and is discussing distribution with some retailers, Lyle says.

Service will be handled in 30 U.S. cities through CDI's service organization. The company has a toll-free number so that users can access hardware and software specialists in its Burlington headquarters. CDI is arranging CompuServe access to provide computer users with one hour weekly of remote computer service through CompuServe's CIS. Additional time is billed at the CompuServe rate. The company also supports pass-through warranties on the computer, which means warranty time is calculated from the day an end user receives the product, rather than the day it is delivered to the distributor.

COMPAQ will support service by distributors or dealers, most of which the company hopes will be IBM dealers. Both products will be available in January.

—Lori Valigra

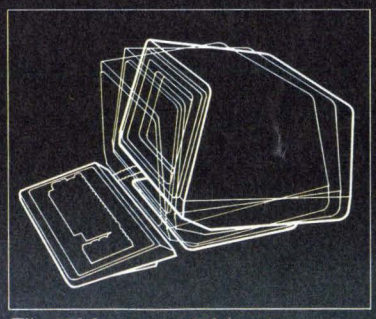
DSD stackable modules give OEMs system packaging alternative

How a system is packaged is most often the concern of a system OEM. The OEM usually decides whether the hardware will appear at the end-user site in a black box, under a table or mounted in a rack.

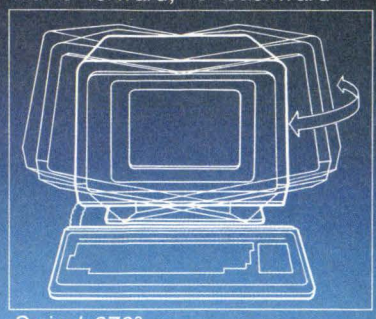
Data Systems Design thinks these approaches are well and good, but the San Jose, Calif., mass-storage subsystem manufacturer is betting that system OEMs are ready for another look. This month, the company begins delivering a series of low-profile, stackable storage subsystem and processor modules that DSD calls Stacpacks. DSD is targeting the hardware primarily at the Digital Equipment Corp. Q-bus and Intel Corp. Multibus markets. But marketing manager Gene Banman says the processor and subsystems will be applicable to other markets as well.

What motivated DSD to develop the new packaging design was the availability of small storage devices such as 5¼-in. Winchester disks and 5¼-in. and slimline 8-in. floppy disks, says Banman. "None of this hardware lends itself well to rack-mounting, DSD's traditional packaging approach," he says. The new packages provide the company with a product line aimed more at commercial customers than technical OEMs.

VISUAL presents ergonomic elegance and high performance in a low-cost terminal.



Tilt: 10° forward, 15° backward



Swivel: 270°

$695 list

The VISUAL 50 represents a new approach in low cost terminals. Although it costs drastically less, it offers the features you expect from the high priced units.

For example, the VISUAL 50 enclosure is ergonomically designed in light weight plastic and can easily be swiveled and tilted for maximum operator comfort. A detached keyboard, smooth scroll, large 7 × 9 dot matrix characters and non-glare screen are a few of the many human engineering features normally offered only on much higher priced terminals.

Another distinctive feature of the VISUAL 50 is its emulation capability. VISUAL 50 is code-for-code compatible with the Hazeltine Esprit,™ ADDS Viewpoint,™ Lear Siegler ADM-3A™ and DEC VT-52.® Menu driven set-up modes in non-volatile memory allow easy selection of terminal parameters.

And you're not limited to mere emulation. As the chart shows, the VISUAL 50 has features and versatility the older, less powerful low cost terminals simply cannot match.

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FEATURE COMPARISON CHART

FEATURE	VISUAL 50	Hazeltine Esprit	ADDS Viewpoint	Lear Siegler ADM-5	Televideo 910
Tilt and Swivel	YES	NO	NO	NO	NO
Detached Keyboard	YES	NO	YES	NO	NO
N-Key Rollover	YES	NO	YES	NO	NO
Audible Key Click	YES	YES	NO	NO	NO
Menu Set-Up Mode	YES	NO	NO	NO	NO
Status Line	YES	NO	NO	NO	NO
Full 5 Attribute Selection	YES	NO	NO	NO	YES
Smooth Scroll	YES	NO	NO	NO	NO
Line Drawing Character Set	YES	NO	NO	NO	NO
Block Mode	YES	YES	NO	NO	YES
Insert/Delete Line	YES	YES	NO	NO	YES
Bi-Directional Aux Port	YES	YES	NO	YES	NO
Columnar Tabbing	YES	YES	NO	NO	YES
Independent RCV/TX Rates	YES	NO	NO	NO	NO
Answerback User Programmable	YES	NO	NO	OPT.	NO

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CIRCLE NO. 23 ON INQUIRY CARD

Data System Design's modular product packaging *allows OEMs to buy the modules needed to complete a system and stack them in a way that matches a user's tastes.*

Several modules are available for processors and mass storage. Though DSD's market has long been disk and tape subsystems, Banman says the company had to offer a processor module "because we had to have a processor box to match the storage boxes." DSD does not manufacture the processor board, but the processor module will be sold with at least one DSD-built controller, Banman says.

Besides a controller, the processor package includes a six-slot Q-bus or Multibus card cage and five RS232 connectors. DSD expects OEMs to use DEC LSI-11/02s or 11/23s, Intel 8086s or Motorola 68000s as CPUs. Banman says DSD may offer an Intel or DEC CPU board in the future.

The controllers DSD will incorporate into the processor modules are the model 7215 8-in. Winchester/tape-cartridge controller or the model 5215 5¼-in. Winchester/tape-cartridge board for Intel processors. For the DEC market, DSD will offer its models 4140 8-in. floppy disk, 8220 5¼-in. Winchester disk/floppy disk, or 8240 8-in. Winchester disk/tape-cartridge boards.

For Intel systems, DSD plans 10M- and 40M-byte, 8-in. Winchester disk modules; a 20M-byte, ¼-in. streaming-tape module using the Archive Corp. hardware; a 10M-byte, 5¼-in. Winchester disk and ¼-in. tape-cartridge drive module; a 10M-byte, 5¼-in. Winchester and 5¼-in. floppy disk module; and an 800K- or 1.6M-byte, 8-in. slimline floppy disk module.

DEC-compatible systems include a 10M-byte start/stop tape-cartridge drive module (using the Kennedy Corp. device) that emulates DEC's TS-11 tape drive; 10M-, 20M- or 40M-byte, 8-in. Winchester disk drive modules that emulate the RL01; and an 800K- or 1.6M-byte, 8-in. slimline floppy disk module that emulates the RX02. A module with a 5M-, 10M- or 20M-byte, 5¼-in. Winchester and a 5M-byte, 5¼-in. removable disk-cartridge drive is planned for next year.

Banman says a system using 5¼-in. peripherals, including CPU boards, I/O boards and memory, could sell for less than $10,000. A system built with DSD's 8-in. peripheral packaging could be priced between $15,000 and $18,000.

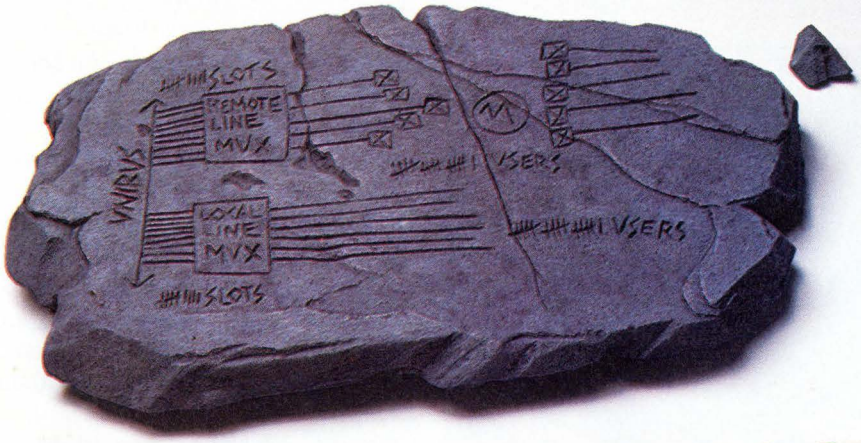
—Larry Lettieri

Color CAD display handles VT-100 alphanumeric code

There's only so much room on an engineer's desk and in a design department's budget—often not enough for each engineer to have a high-performance graphics terminal for CAD and an alphanumeric terminal for coding. But now, Megatek Corp., San Diego, hopes to meet those price/performance and footprint requirements with its Whizzard 1650 terminal, which combines high-performance graphics and alphanumerics functions in one package.

The 1650 is Megatek's entry into low-end CAD/CAM hardware. Graphics consultant Carl Machover predicts that market will grow twice as fast as the general CAD/CAM market. The company has implemented some bit-slice hardware functions of its high-end color raster terminals in firmware, which sacrifices real-time speed for economy, restricted function to 2D and added a true alphanumeric overlay that is VT-100/VT-52 code compatible. The OEM terminal is targeted for use on large DEC PDP-11 and VAX superminis, as well as other minicomputers. Single-unit price is $15,900, with discounts of about 30 percent

Emulex solves the age-old problem of communicating with a DEC computer.



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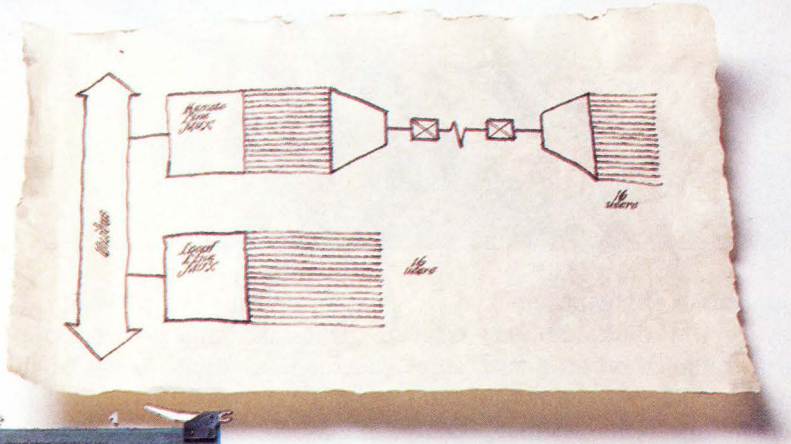

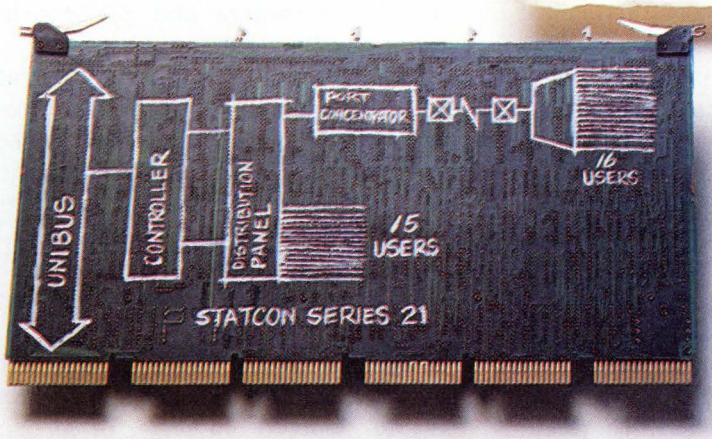

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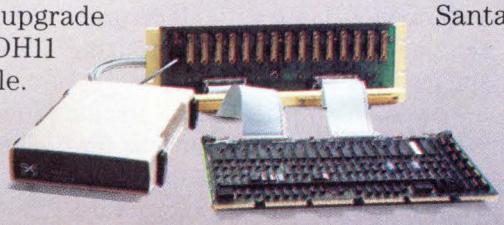

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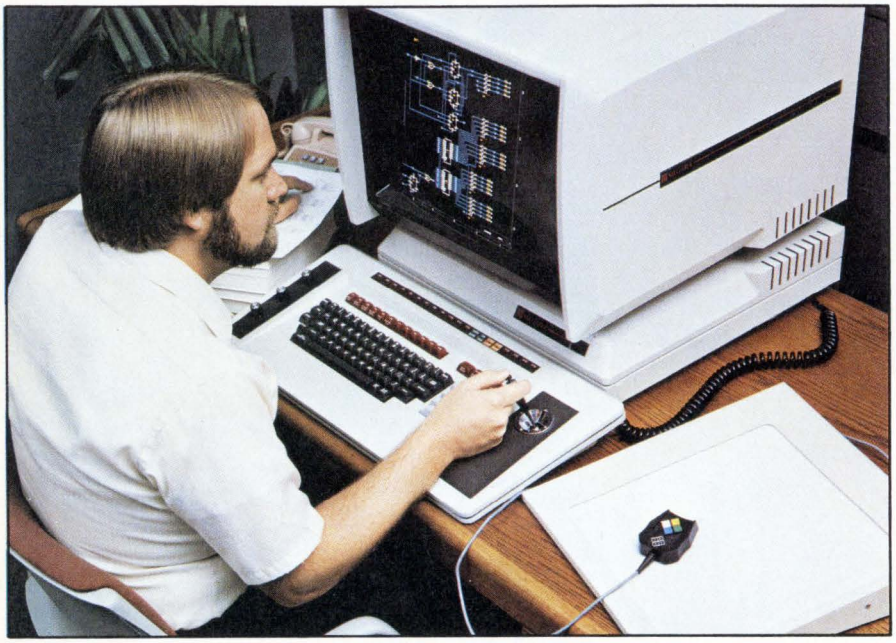

for quantities of 200 units.

Key to the 1650's $15,900 basic price is reliance on an 8-MHz Intel Corp. 8086 microprocessor to handle communications, memory management for as much as 256K bytes of display-list RAM, graphics processing and vector setup. Firmware functions such as polygon pixel fill and coordinate translation are stored in as much as 64K bytes of EPROM. A hardware digital vector generator performs screen edge clips for viewporting and achieves write rates of 270 nsec. per pixel. Viewable resolution on the 19-in. monitor is 640 × 480 pixels at 47-Hz interlaced or 60-Hz noninterlaced operation. The monitor can be tilted 20°. Four bit planes and a 12-bit programmable look-up table provide 16 colors from a palette of 4096.

The product's 8085-based keyboard with palm rest is said to meet German ergonomic specifications. Modeled on the VT-100 keyboard, it features 16 programmable function keys with lights, five cursor control keys, a 14-key numeric accounting pad and an audible bell. A joystick and three programmable valuator dials are optional.

Optional input devices supported include a light pen—capable of character resolution and of returning xy coordinates directly to a user or to the pick firmware—and an RS232 data tablet. Output is through a Centronics-compatible interface to hard-copy devices or via a video RGB interface to camera systems. The graphics and character overlays can be spooled separately.

Despite all these functions, the 1650 is not for all graphics applications. Megatek president Peter Shaw says the 1650's single-buffered output design—unlike a double-buffered design in which one image can be displayed while the next is written—makes it unsuitable for real-time dynamics, for example. But, he says, the 1650 will be strongest in IC-mask, custom gate-array-design, electronic-schematics and PC-board-routing applications.

For such applications, circuit functions—components such as flip-flops and NAND gates—need be defined only once as subroutines and then called from various screen locations as needed, which conserves display-list memory, explains Megatek senior project engineer Jeff Ponsor. Ponsor says the 256K bytes of display-list memory can logically support any combination of as many as 4095 component types (subroutines) and layers (segments), although memory will probably run out at about 1000, he says.

James Warner, president of graphics software vendor Precision Visuals, Inc., says that 1000 segments or subroutines is sufficient for most purposes. But he questions whether the 1650's 4K × 4K virtual display space is sufficient for elaborate electronic layouts. The competitive Hewlett-Packard Co. HP2700 color raster terminal offers 32K × 32K. "That might be overkill," says Warner, "but many film recorders and plotters have resolution that fine."

The HP and new Megatek terminals both use firmware to do local transformations (rotate, scale and clip) as does the competitive Tektronix, Inc., 4113. Such functionality is often used in CAD—for example, a NAND gate can be rotated on the screen to the correct orientation.

But Mark Reiss, product line manager for the competitive Ramtek Corp. 6200 series of terminals questions the efficacy of local coordinate translation without special-purpose hardware. A microprocessor is too slow, he says. "Our philosophy is that if you can't do it quickly, you're better off doing it in the host and sending it back to the terminal via a fast parallel interface," says Reiss.

But Megatek's Ponsor notes that local transformations cut the amount of information that passes to and from the host over the relatively slow serial interface used

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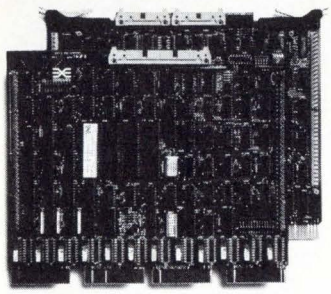

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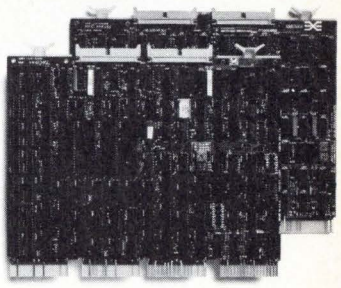

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Multi-user	Std.	Opt.	No	Std.
Multi-programming	Std.	Opt.	No	Std.
Hard disk	10MB Std.	8.6MB Std.	8MB Std.	20MB Std.
Tape backup	Std.	No	Opt.	Opt.
Floppy disk	No	Std.	Std.	Opt.
Standard memory	128KB	32KB	256KB	256KB
Maximum memory	1024KB	256KB	1024KB	1024KB
Single desk top unit	Std.	No	No	No
Memory Speed	300ns	600ns	Unkn.	480ns
Memory ECC	Std.	No	No	Std.
15" screen	Std.	No	Std.	No
Cost	$12,995	$18,465	$20,460	$46,000
Extra cost items	lang.	os, lang.	lang, opts.	lang, opts.
Price of each system configured to 128KB RAM, 6 serial ports, 4 user terminals, 10MB hard disk, tape backup:	$14,495	$33,205[1]	$32,750[2]	$54,000[3]

[1] 8.6MB disk drive, no tape, floppy backup

[2] 8MB disk drive, no tape, floppy backup, network configuration, 256KB RAM

[3] 20MB disk drive, no tape, disk pack backup, 256KB RAM

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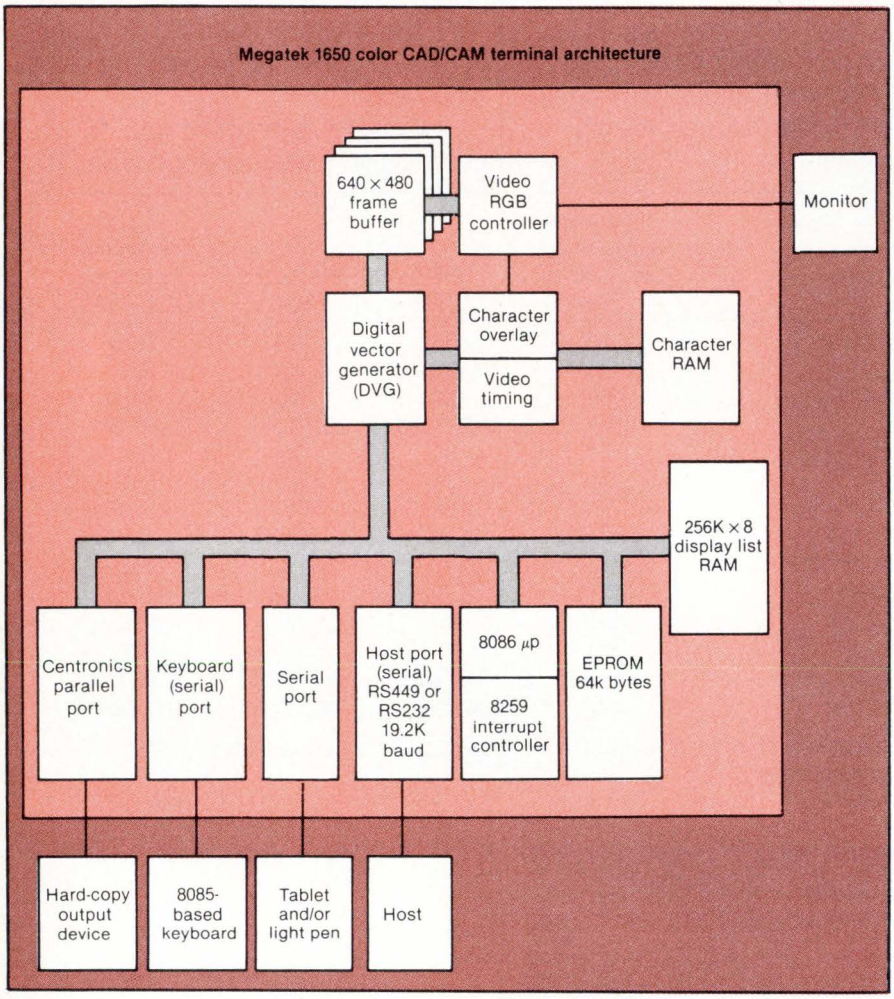

in remote terminal locations, such as an engineer's office.

Chromatics, Inc., Tucker, Ga., markets the $20,000-plus CGC 7900 workstation that Megatek president Shaw sees as a competitor of the 1650. Don McKinney, director of product marketing for Chromatics, says the 7900 does not support local display-list processing or transformations. "Display-list processing is merely a way for older software written for stroke writers to migrate to color graphics," he says. He notes that newer software, such as that used on 7900s throughout Bell Laboratories for IC design, does not use display lists to draw. But he admits a demand for local display-list processing exists; some customers of Chromatics have written software to support it.

Ponsor notes that although the higher end 7000 series Megatek terminals are still an order of magnitude faster at display-list processing, software compatibility with the 7000 series terminals provides an upgrade path for 1650 users. That is a key strategy in Megatek's marketing. "The common link is Megatek's Wand software," says Ponsor, "which lets the application programmer specify vector-drawing commands and takes care of everything below that."

Ponsor emphasizes one last attraction offered by the 1650: its line analyzer, which displays all communications traffic between the 1650 and the host in a separate screen window in single-step or multiple-breakpoint mode for software debugging.

"We got the VT-100 overlay and line analyzer up first, and then used the 1650 to write the 1650's software," says Ponsor. "I just don't know what we would have done without that line analyzer."

—Kevin Strehlo

Intel's 16-bit microcontroller aimed at high-speed, real-time markets

It seems Intel Corp.'s 125-percent solution has produced the desired results. The company's plan to improve corporate productivity, aimed at getting new products out the door, has resulted in several significant introductions over the past year, not the least of which were the iAPX 286 and 186 processors and a line of microcomputer systems.

Now, the Santa Clara, Calif., company plans to begin delivering the 16-bit, single-chip 8096 microcontroller, the latest member of a controller family that includes the ubiquitous 8048 8-bit component. With the 8096, Intel executives say, the company will attack process control, robotics and telecommunications—high-speed, real-time ap-

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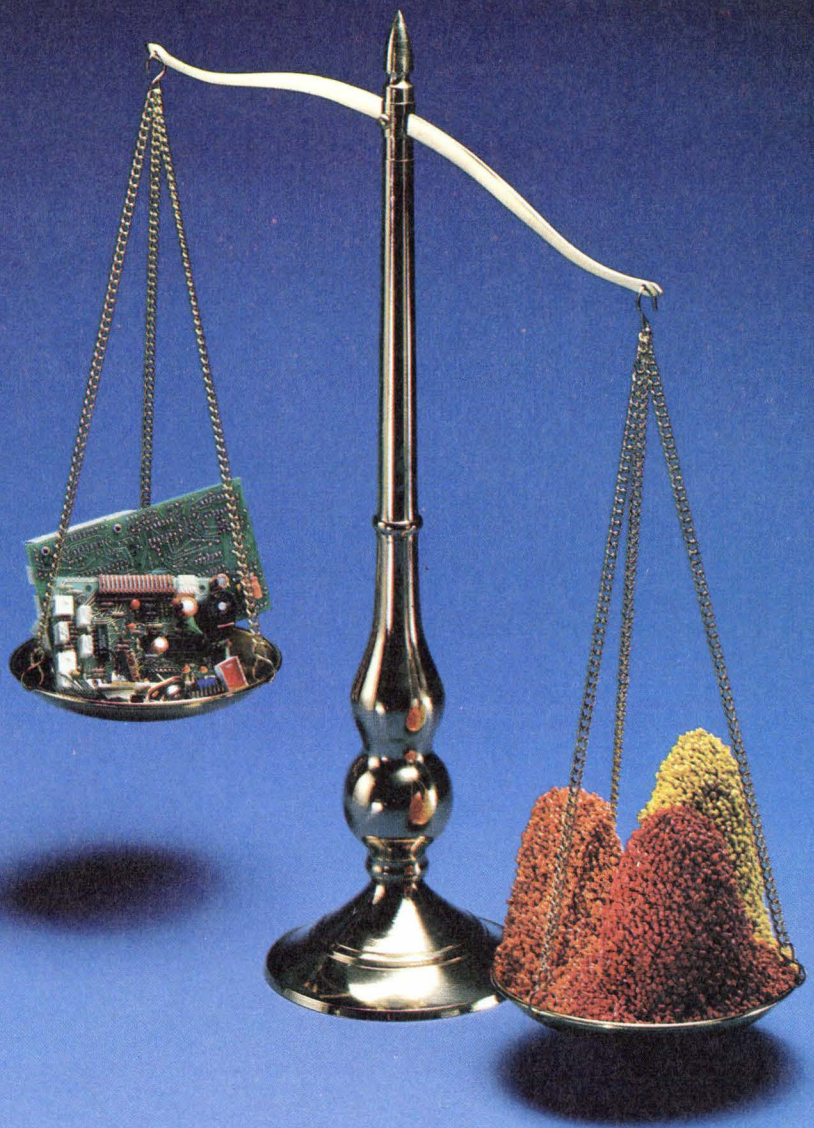

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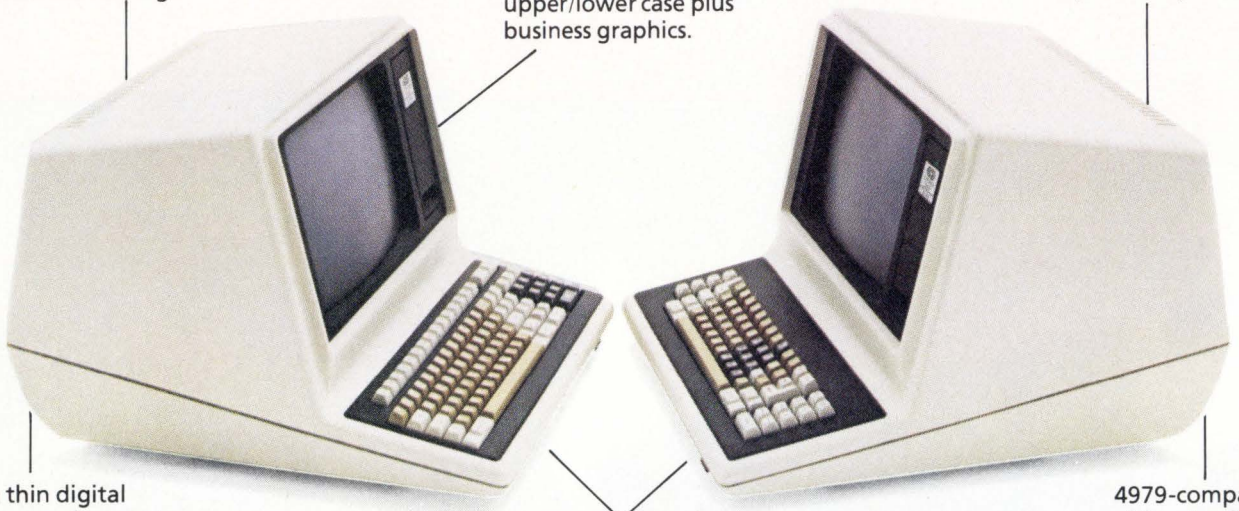

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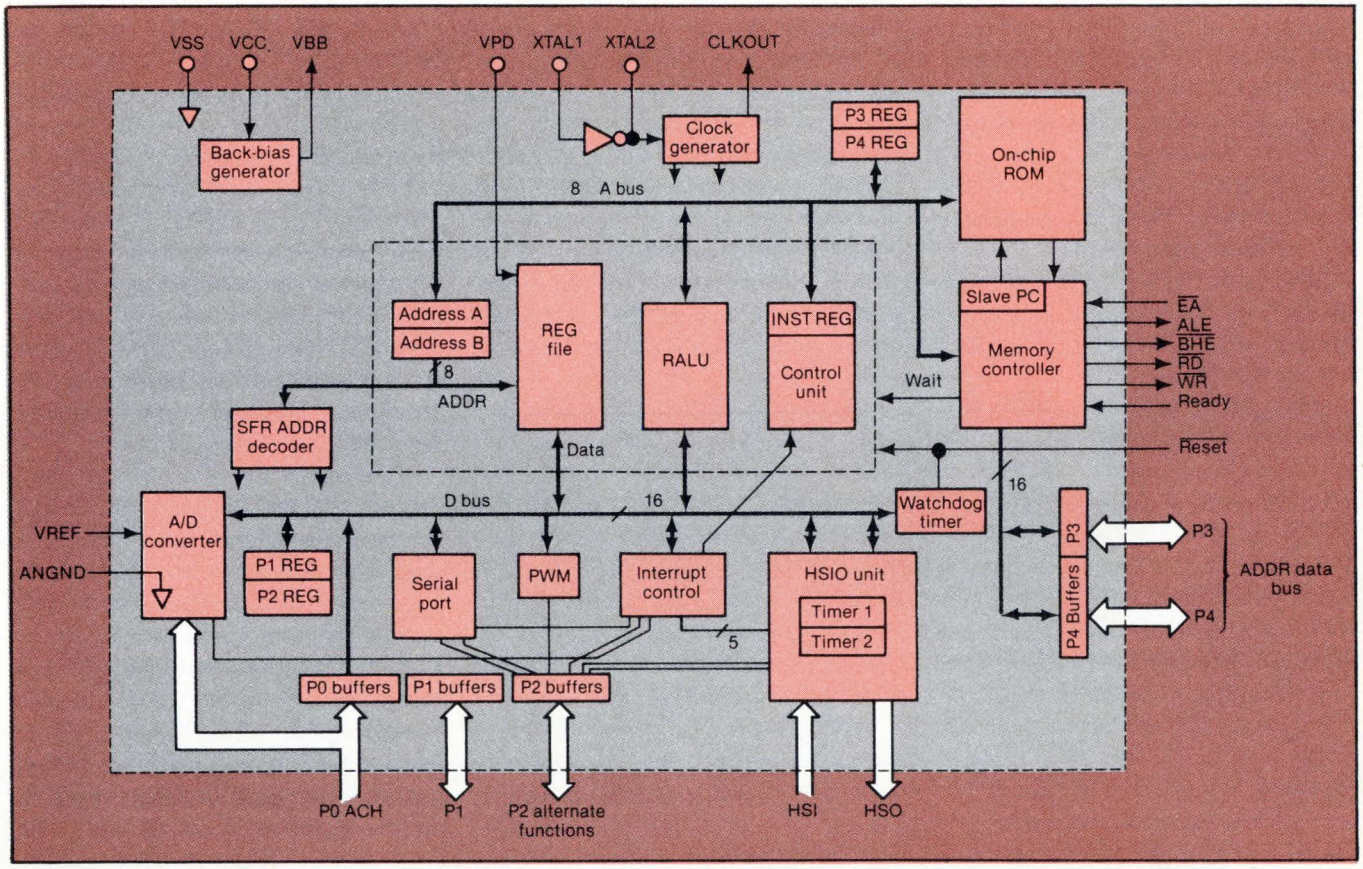


plications traditionally dominated by board-level hardware built with TTL logic and bit-slice technology. The company also expects the 8096 to find use as a control mechanism for high-speed peripherals such as printers and Winchester disk drives.

The market for the 8096 is considered small. Intel's microcontroller operation marketing manager, Joe Baronowski, says sales are expected to be "in the thousands of units." He hopes, however, that by 1985-86, the market will explode to 5 million to 10 million units.

Competitively, Intel stands somewhat alone in the market. "We think we're a year or two ahead of our competitors," says Baronowski. He believes other semiconductor vendors will focus on the 16-bit microcontroller market very soon, however. Texas Instruments Inc.'s 16-bit 99000, introduced last fall, appears to be the nearest competitor to the 8096. National Semiconductor Corp. plans a single-chip version of its NS16000, the NS16010, although it's not due for another year. Motorola, Inc., and Mostek Corp. are said to be jointly developing a single-chip controller for the MC68000 family.

The 8096 has 8K bytes of ROM and a 232-byte register file RAM. The device supports 8- and 16-bit words as well as 32-bit double words via an

INTEL OFFERS VLSI GRAPHICS CONTROLLER

Intel Corp.'s 82720 graphics display controller performs all tasks needed to generate a display and manage display memory in raster-scan graphics and characters. It handles low-level functions such as the basic video raster timing and high-level functions such as zooming, scrolling, screen partitioning and drawing into the memory bit map. The 82720 supports both the NAPLPS and VDI standards. The GDC handles a bit-map configuration as large as 4M bits—for example, four 1K × 1K bit planes could be used for 16-color output. Alternatively, for monochrome pixel writes as high as 40 MHz, the GDC could partition its video memory into four display banks. Priced at $75 in quantities of 100, samples of the 82720 are available now, with full distributor stocking planned for the first quarter of 1983.

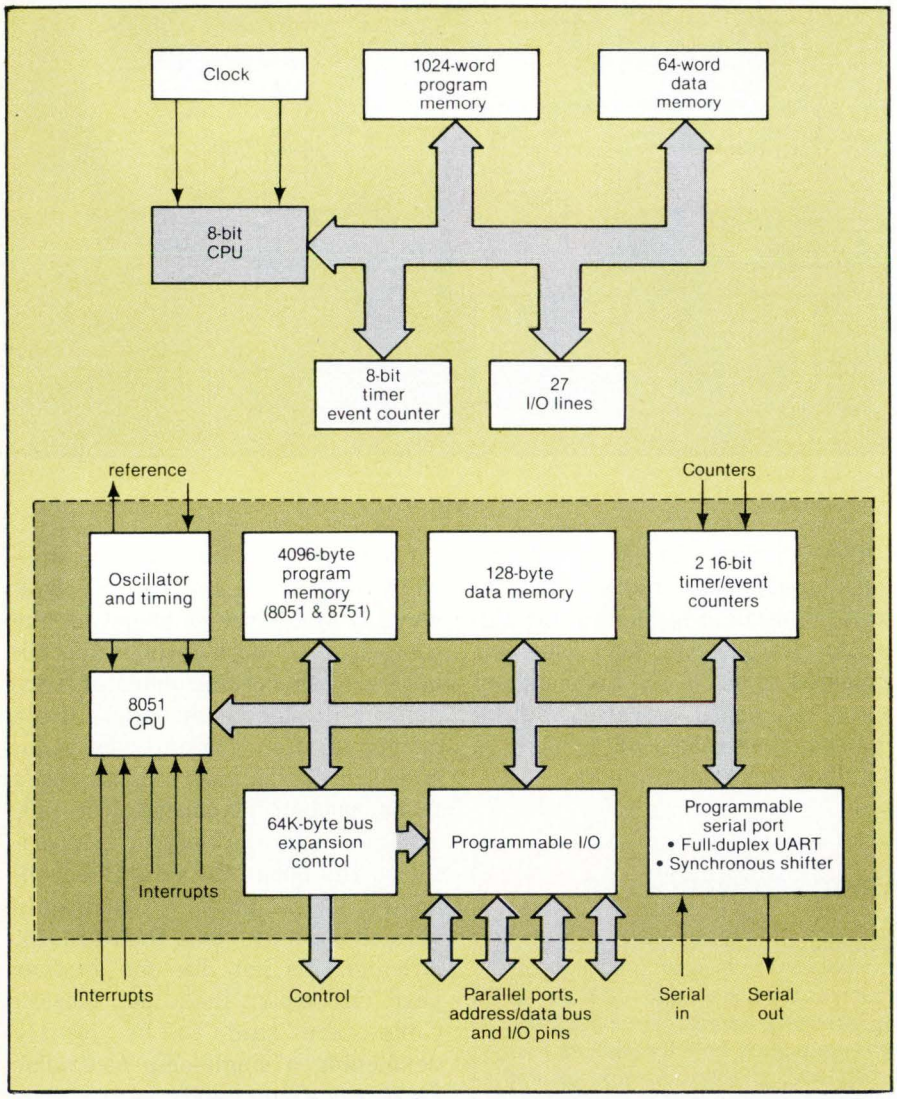
instruction subset. It has 64K bytes of memory address space, and its I/O includes an eight-level priority-interrupt structure, analog input, full-duplex serial I/O and 40 parallel I/O ports. It also includes an on-chip, eight-channel, 10-bit A/D converter. Implementing these functions usually requires many chips.

Intel says the 8096 can considerably reduce parts counts in most applications. Any control application that has used multiple chips is a candidate for the 8096, Baronowski says. One result of the diminished chip count is a smaller PC board than previously required. Both the reduced parts count and the smaller board contribute to a reduced price for most applications. The 8096 will sell for $15 in quantities of 10,000 when production volumes are reached in early 1983. Multiple chips performing a similar function, Baronowski adds, could sell for as much as $50. A bit-slice implementation of comparable functions—considered to be at the upper end of 8096's ability—would be priced much higher, Baronowski says.

The 8096's low price may be attractive to peripheral-controller designers, especially those planning Winchester disk drives. A single-chip controller could substantially lower the prices of these mass-storage devices. Disk drive industry observers, however, express mixed reactions.

"Reducing the chip count and, therefore, the size of a PC board would necessarily drop the price of a stepper motor or voice-coil controller," says Newark, Calif.-based disk drive industry analyst Andrew Roman. He questions the effect a 16-bit device would have on the overall design of such a controller, however. "While the device would reduce chip count in some areas, it might increase it in others," he speculates. More support chips might be needed because of the 8096's complexity compared with a similar controller built with an 8-bit device such as the 8048.

Disk drive controller consultant Dick Oswald also questions the efficacy of using the Intel chip in disk drives. "In general, microprocessor technology is not very useful in high-performance disk actuators," he says. The limitations of using a processor in such applications is speed. It's not practical to compute the motion of a voice-coil actuator each time the head is repositioned, for instance, he points out. The best actuator controllers have been implemented using combinations of ICs and analog components, he adds. He sees devices such as the 8096 useful as interface controllers for reading or writing on a disk and similar functions. But the 8096 will not have a considerable impact on



Microcontroller architectures from Intel Corp. *have grown more complicated since the first such component was introduced six years ago. The 8-bit 8048 (above), head of Intel's MCS-48 family, has 1024 bytes of ROM and 64 bytes of RAM. There are 27 I/O lines. A CPU redesign resulted in the 8051 (below) about four years later. Still an 8-bit processor, the 8051 includes a CPU that can address 128K bytes of program and data RAM, 4K bytes of ROM, 128 bytes of RAM and 32 I/O lines. There is also a pair of 16-bit event counter/timers and a full-duplex serial interface.*

Continued on page 55

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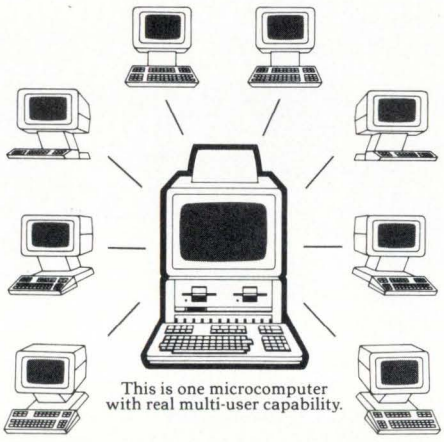

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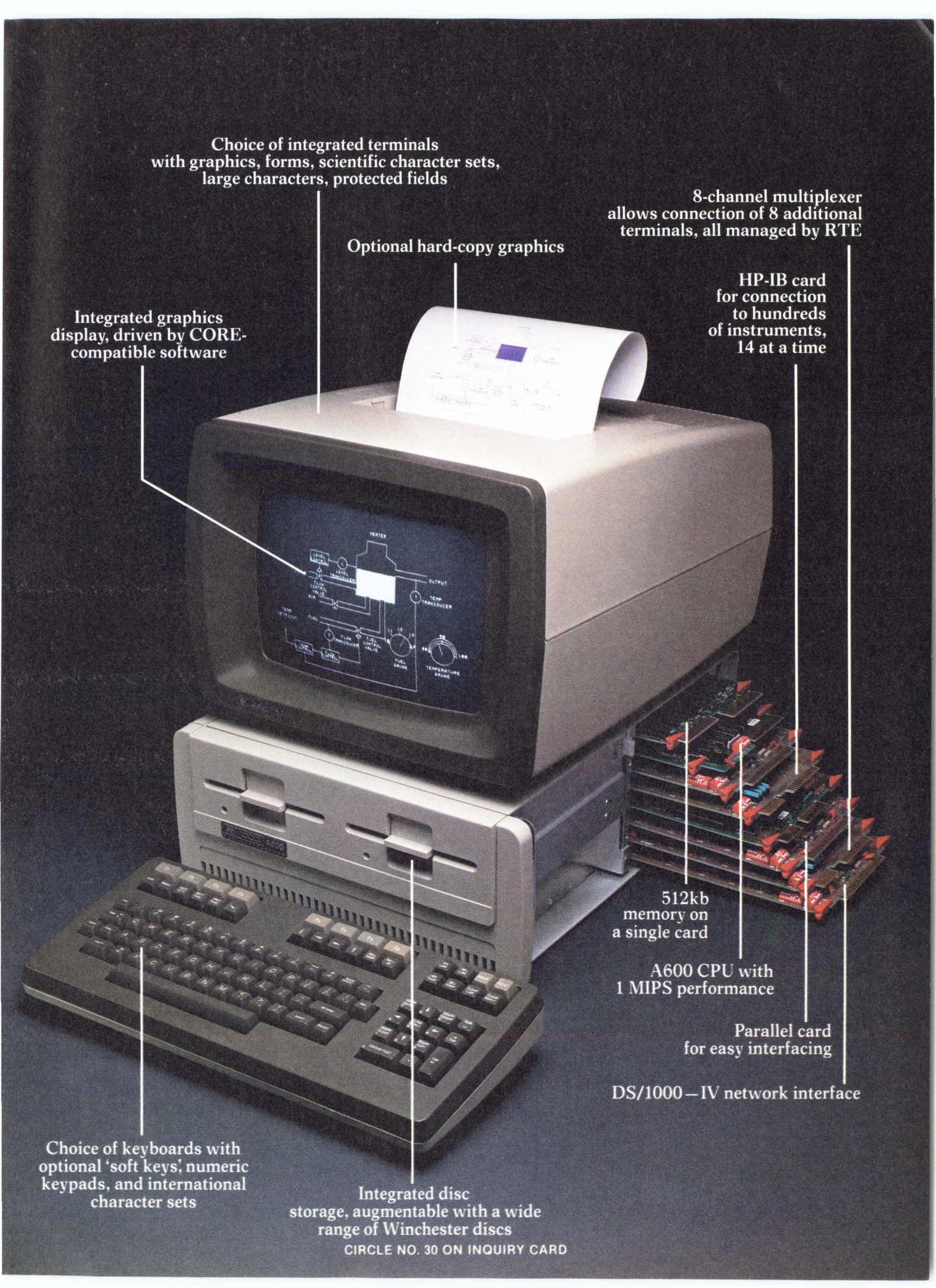

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Continued from page 48

positioning functions, especially for voice-coil actuators, Oswald believes.

Although Intel says the 8096 will provide high throughput in peripheral-control applications, the company has not yet looked at specific applications, such as disk drive controllers, officials say.

Production versions of the 8096 will use Intel's HMOS III process. The 8796, a version with 8K bytes of EPROM, is planned for the second quarter of next year. —*Larry Lettieri*

Tektronix color printer intended for CAD markets

A color ink-jet printer that provides possibly the highest resolution in its price range will be unveiled this month by the Information Display Division of Tektronix, Inc. The model 4691 printer offers a resolution of 150 dots per in. both horizontally and vertically, compared to 85 × 140 dpi for its nearest known rival, prints eight colors and is intended initially as a companion device for the Tektronix 4113 intelligent color terminal. That terminal is widely used in the electrical and mechanical segments of the CAD market. The printer's price hasn't been finalized; Tektronix is aiming for a target of $12,500.

The printer will be introduced in Philadelphia at the November 29 - December 2 Autofact IV conference and exposition on the automated integrated factory. Catherine Cramer, marketing product manager for the printer at the Tektronix division in Wilsonville, Ore., says the model 4691 embodies at least two other features besides high resolution that were not previously available in this class of color printers: the ability to print on standard A-sized (8½ × 11 in.) and B-sized paper (11 × 14 in.), and the ability to print true black along with three primary colors—cyan, yellow and magenta.

The single-pass, ink-on-demand unit links to the 4113 color terminal by means of a Centronics-type parallel interface. It prints a copy of the CRT image by program command or if a user presses the copy key on the terminal keyboard. Until now, says Cramer, all of the company's printers have printed only on A-sized paper. "B-sized output is good for complex graphics," she says, "and is often preferred for very detailed drawings and as working copy for larger screens."

The 4691 uses four ink-jet heads to supply the three colors and black. An airflow process provides one drop of ink for every electrical pulse received, says Cramer, which heightens resolution.

The printer initially produces eight colors, but other colors can be achieved through dithering, a process that uses a limited choice of colors. Placing drops of the colors next to one another in patterns produces a half-tone effect because the eye integrates the colors so that another shade appears. For example, if red and blue dots are closely placed, the combination appears as purple.

The 4691's ability to print true black is a feature Cramer says is not offered by other ink-jet printers, which must mix primary colors to achieve black. This can produce an off color and is a waste of ink, she adds. "It (adding true black) does add an extra cost to the unit," Cramer concedes, "but we think it's well worth it for what you get in image quality."

Using airflow in the ink-jet head to produce smaller droplets, the printer can accurately place drops on the paper. The smaller dots allow a 150-dpi density in both directions, or 6 dots per mm.

An A-sized copy takes about 2½ min. per page, and B-sized takes 4 min. Cramer says Tektronix's A- and B-sized price-per-copy targets are 15¢ and 20¢, respectively, which includes the price of ink.

YOKOGAWA SEEKS DEALERS FOR PLOTTERS

Instrumentation company Yokogawa Electric Works, Smyrna, Ga., hopes to sign its first dealers for the new three-member, four-color plotter family at this month's Comdex show in Las Vegas. The PL-1000, PL-2000 and Graphmate II plotters, the company's first attempt at marketing commercial plotters in the U.S., will sell for approximately $1200, $2000 and $2800, respectively. The low-end PL-1000 offers RS232C and Centronics parallel interfaces and nine line styles, handles paper as large as 11 × 15 in., and produces foil transparencies. Water-based pens are standard, with a ceramic-tip pen optional. The PL-2000 accepts standard-sized paper and features selectable plotter speeds as high as 20 cm. per sec. and a 1K-byte internal buffer. Ceramic-tip or oil-filled pens are available. The stand-alone programmable Graphmate II features an alphanumeric keyboard with LCD and a 4K-byte buffer memory. Ceramic-tip pens are standard. An optional micro disk drive is available. The 2000 and Graphmate offer a graphics ROM option, which provides three types of bar graphs, line graphs and pie charts. Production quantities will be available by January.

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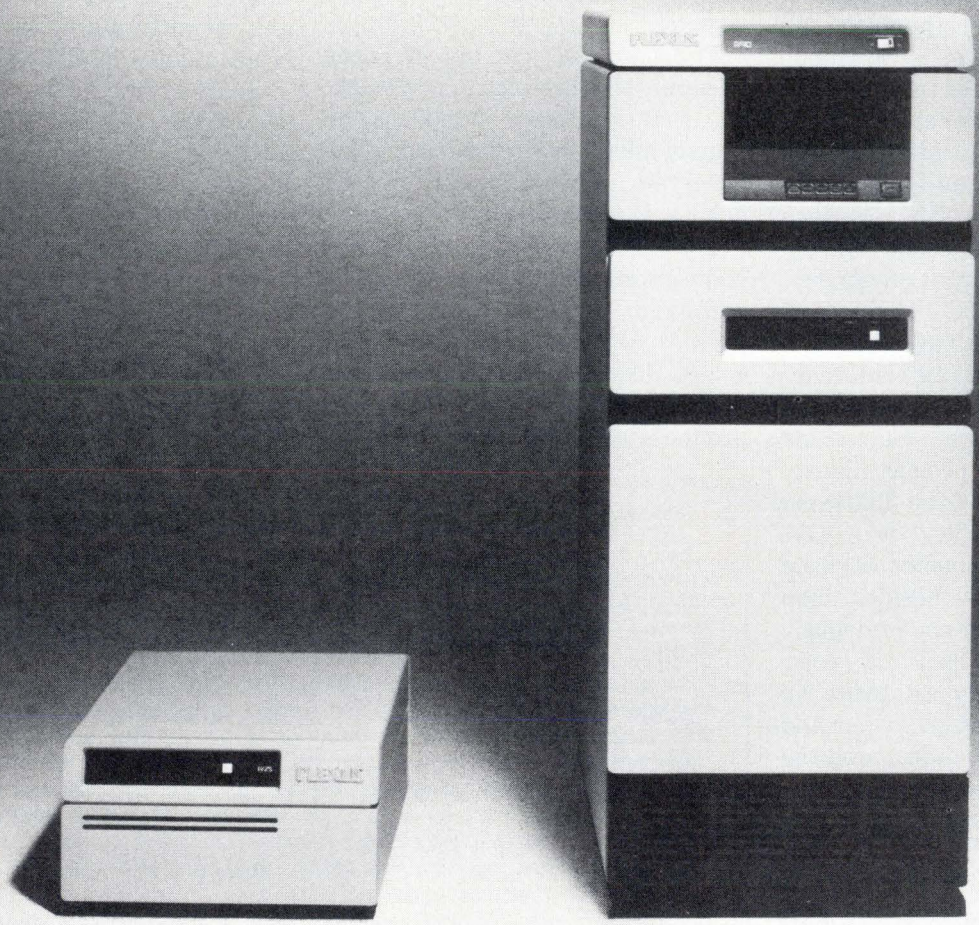

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The P/40 offers an impressive 72 system combinations. With its three disk sizes. (72, 145 and 290 megabytes.) Eight memory sizes. (½, 1, 1½, 2, 2½, 3, 3½ and 4 megabytes.) And three user configurations. (8, 16 and 24 terminals.)

All these options are offered with a single vision in mind.

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With 96 possible system combinations, Plexus gives you the opportunity to custom-build systems to your ideal specifications.

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Helping you to more effectively control your costs.

So you can maximize your profits.

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Compare our two systems to the others. Price, performance, delivery, support and configurations. Once you do, you'll see. There's more to Plexus, than what meets the eye.

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CIRCLE NO. 33 ON INQUIRY CARD

Cramer says Tektronix intends the printer for the business graphics, scientific, cartography and CAD markets. "The first and primary market for us right now is through the 4113 because it offers a load-and-go capability," Cramer says. The markets served by the 4113 are the electrical and mechanical engineering segments of the CAD market and the cartography market. "In business graphics," says Cramer, "we're heading for the technical market and the people in it who do management graphing."

Early entries into this market haven't provided high resolution and quality, Cramer says. She notes that color is on everybody's mind. "Advanced Color Technology, PrintaColor Corp. and Applicon, Inc., all produce ink-jet devices now," she says, "and there will probably be more major vendor entries over the next few years." Hewlett-Packard Co. and IBM Corp. are working on color copiers using various technologies, she says.

The ACT 1 from ACT, Chelmsford, Mass., an ink-jet color printer, offers an 85- × 140-dpi resolution for $9000. PrintaColor, Norcross, Ga., recently introduced its PG-1000 color graphic ink-jet printer, which can print as many as 125 shades on standard-sized paper in about 2 min. This printer is plug-compatible with IBM PC and Apple III computers and retails for $4995. PrintaColor also offers the GC 8000 desk-top, drop-on-demand, hard-copy device, which delivers 90-dpi resolution for $3995. At the high end is the company's GP 1024 color desk-top ink-jet printer, with selectable dot densities of 45 to 120 dpi at $5495. PrintaColor's HR 8002 desk-top, drop-on-demand, color printer offers a 90-dpi dot density and retails for $4995.

Tektronix will sell the 4691 copier through end users and OEMs. Production quantities and deliveries are expected to begin during the first quarter of 1983.

—Nancy Love

Sub-4-in. floppy drive ready at Comdex

In a move that challenges efforts by a group of manufacturers to establish uniform specifications for sub-4-in. floppy disk drives (MMS, October, p. 00), Tabor Corp., Westford, Mass., will introduce at Comdex in Las Vegas this month hardware that uses 3¼-in. media. The company is funded by Santa Clara, Calif., media-maker Dysan Corp., which will supply the soft, vinyl-encased diskettes rather than the harder, plastic-enclosed media proposed by other manufacturers such as Sony Corp.

Called the Drivette, the 140-tpi, 9250-bpi device has 80 tracks per side. Head-positioning time is 10 msec., and rotational speed is 300 rpm. Capacity is 500K bytes. The package is 1.62 × 4 × 5.5 in.

The Drivette represents another choice in the widening field of sub-4-in. hardware, a race started more than a year ago by Sony's 3½-in. microfloppy. Sony's spec stands on one side of an imbroglio that could take some time to sort out. On the other side is a group of U.S. drive and media companies, including Shugart Associates and Verbatim Corp. (Dysan and Tabor had been members of this group, but withdrew over disagreements on diskette packaging.) Adding support to Sony's dimensions are drive builders Tandon Corp., Chatsworth, Calif., and Seagate Technology, Scotts Valley, Calif., both of which have chosen the Japanese company's specs for their planned hardware. Further, several companies with media sizes as small as 3 in. are fueling the debate.

Several proposals for a sub-4-in. floppy disk drive standard have reportedly been presented to ANSI for consideration. What the outcome will be is difficult to say. The stakes are a market that could reach $200 million in 1986, according to Andrew Roman, publisher of the *OEM Disk Drive Pricing Report*, Newark, Calif.

Tabor president Mike Hanley says of the standards debate: "It could go on for another year. It's anybody's guess how it will all shake out." He expects the situation to clear up a little by the end of the first quarter of next year, however. "By then, everyone will have played their hands."

Meanwhile, Tabor will be in production with the Drivette this month, although Hanley will not give estimates for quantities. He hedges on pricing, too, saying that prices will be competitive with those of 5¼-in. floppy drives.

The current 10,000-and-up price for a 96-tpi, single-sided floppy is about $185, analyst Roman says. Sony's price for 10,000 or more units of its microfloppy is about $215. The 3½-in., single-sided Sony drive holds 437K bytes, unformatted, and operates at 135 tpi and 7610 bpi. Analyst Roman says prices for the sub-4-in. hardware initially will remain higher than those of 5¼-in. drives "because there is a premium to be paid for the compact packaging."

Hanley is aiming the Drivette at diverse markets. Among them are memory typewriters, personal and professional computers, portable computers and test equipment.

—Larry Lettieri

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"We needed a powerful intelligent terminal tailored precisely to our system specifications. And more importantly, we were looking for a terminal manufacturer capable of complementing the way we do business." So says Jim Heslop, Product Specialist for *McDonnell Douglas Automation Company's (MCAUTO) Patient Care System.*

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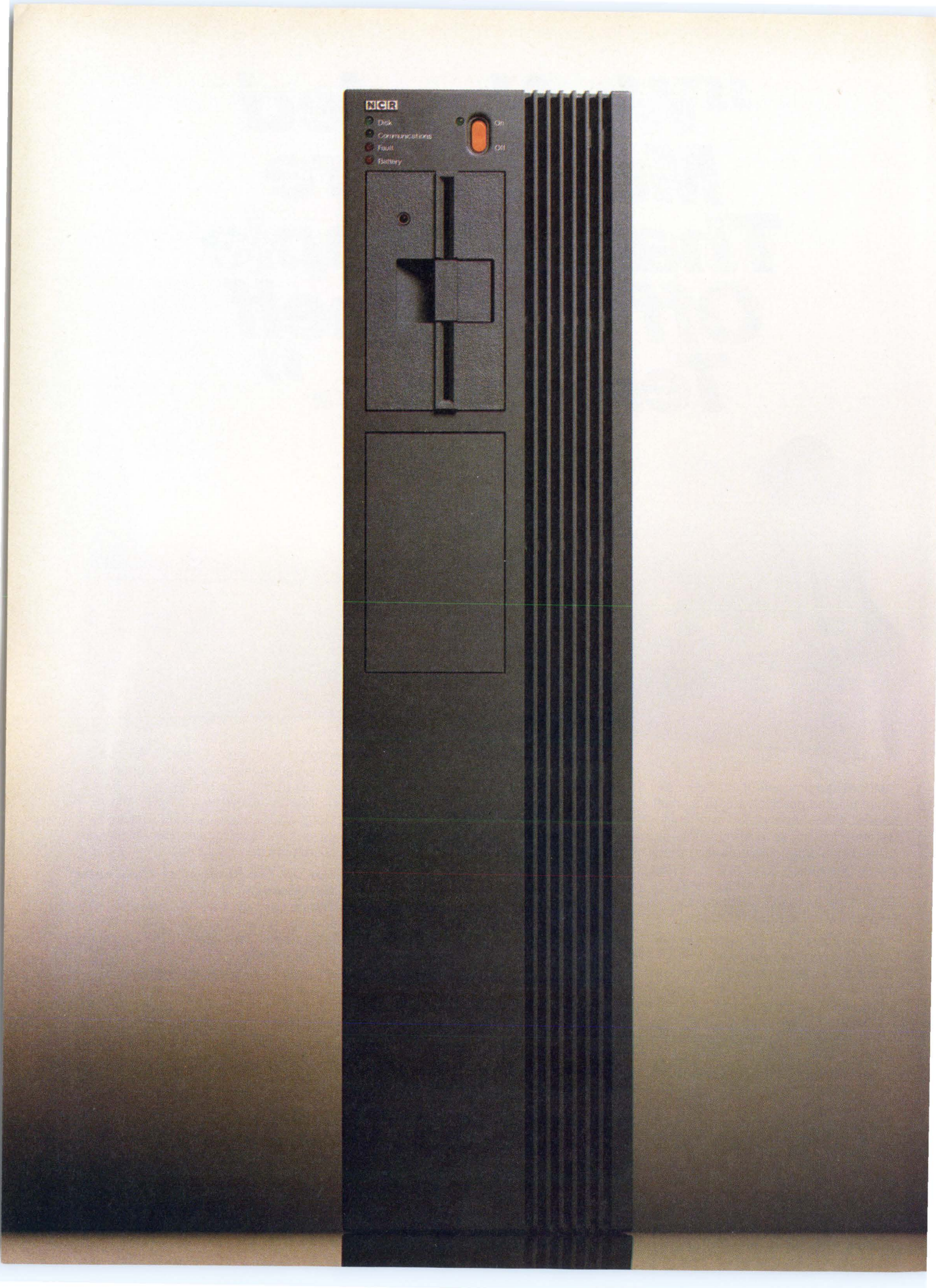
CIRCLE NO. 34 ON INQUIRY CARD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*UNIX is a trademark of Bell Laboratories.

Seiko launches 16-bit business microcomputer

As Epson America is trotting out its 8-bit personal computer this month (see "Epson launches first assault on U.S. microcomputer market," p. 66), the Seiko Group will stake a separate claim in the business microcomputer market with an Intel 8086-based system that will be marketed under the Seiko name through a three-way joint venture.

The joint venture, Sci-Com Computer Systems, Bridgewater, N.J., is backed by the $2-billion Seiko Group, Japanese trading company Tokyo Boeki, Ltd., and Science Management Corp., a U.S.-based technology consulting and computer services firm whose Software Systems division is providing Basic Four-compatible and UNIX-like operating systems for the Seiko 8600 series. The venture has signed an exclusive master distributor program with Reston, Va.-based Intech Systems Corp., which will funnel the products to dealers through 10 regional distributors.

Sci-Com marketing manager Mike Ford says the Seiko Series 8600 products that Sci-Com is launching this month represent an effort unrelated to and different from the Epson microcomputer. The 8600s have been developed and marketed in the Japanese market by Seiko's Seikosha Co. Ltd. subsidiary and are aimed at the higher priced market for which the parent company reserves the Seiko marque, Ford explains.

The base system, with 128K bytes of memory, a floppy, a Seiko 8085-based CRT display, a printer port and four RS232 ports, is priced at $5415. A typical three-user version with MBOS, 256K of memory, a 10M-byte Winchester disk drive and one floppy drive is $12,890.

In an effort to assure price integrity for the products and protection for the "quality image" of Seiko, Ford says, Sci-Com has undertaken a tightly controlled distribution program through Intech, a Digital Equipment Corp. systems house and a distributor of the Xerox 820, Eagle and Micromation microcomputers. Intech has an exclusive contract for the 8600s under which it is committed to purchase $20 million worth of systems in the first year.

With Intech, Ford says, Sci-Com has worked out a "unique" method of getting desk-top systems into dealer/retail channels with the support required to make the product succeed in the market. Intech and its 10 independent regional distributors are contractually obligated to eliminate their other 16-bit systems and concentrate only on Seiko. Many of the distributors are said to have system-integration experience in the minicomputer market and are expected to develop vertical markets for the 8600s. Sci-Com will supply exclusive operating systems, languages and applications for the Seiko systems. Sci-Com expects Intech's distributors to sign as many as 1000 local dealers.

Seiko's 8600 small-business computer *will be distributed exclusively by Intech Systems Corp., Reston, Va.*

The systems, which support one to four users and as much as 20M bytes of Winchester disk storage, are available with a range of operating systems aimed at 8-bit microcomputer users graduating to 16-bit products and minicomputer users looking for lower priced hardware. For the first group, the company is offering CP/M-86, MP/M, MS/DOS and OASIS/16. For the second group, Sci-Com is targeting the Basic Four software base with SMD-developed MBOS, a multi-user BASIC operating system said to be compatible with Basic Four systems. Another SMC product, due out this month, is Unidol, a UNIX look-alike said to be based on UNIX System III. SMC's IDOL and BAS packages for Basic Four users will also be available, as well as a group of industry-standard application packages such as word processing, accounting, forecasting and database management.

—Geoff Lewis

DATAPRODUCTS OFFERS WARRANTY ON PRINT HEADS

Dataproducts Corp., Woodland Hills, Calif., has announced a lifetime warranty on all of its M-120 and M-200 serial matrix print heads. If either print head fails, the company supplies a new one free. The guarantee grew out of quality and reliability programs that allowed the company to offer a full-year warranty on parts and labor on all matrix, daisy-wheel and band printers. The M-200 is a 340-cps printer with a 14-wire print head, and the 180-cps M-120 uses a seven-wire head.

TSX-PLUS™

Time Share RT-11

TSX-Plus™ is a high-performance, general purpose time-sharing extension to the RT-11 operating system for Digital Equipment Corporation PDP-11 computers with memory management. TSX-Plus™ provides the functionality of the Digital RT-11 operating system to multiple users on a time-sharing basis.

TSX-Plus™ should be used:

—to time share the RT-11 environment,
—to increase the productivity of software development,
—to provide a general purpose, multi-language, multi-user operating system environment for data processing, real-time control, software development or training.

RT-11 Compatability: Most RT-11 programs can be used with TSX-Plus™ without change or relinking. TSX-Plus™ interfaces with standard RT-11 device handlers (XM version) and supports RT-11 utility programs such as PIP, DIR, DUP, MACRO, TECO, KED and K52. (The FORMAT program is not supported). Language processors available for use with TSX-Plus™ include COBOL-Plus™, FORTRAN, BASIC, DBL and Pascal-2. The TSX-Plus™ keyboard commands are an extended set of those provided by RT-11. TSX-Plus™ system service calls (EMT's) are compatible with those provided by RT-11.

Efficiency: TSX-Plus™ overlaps terminal interaction time, I/O wait time and CPU compute time for all jobs on the system. The result is a tremendous increase in the productivity of the computer. Compute-bound jobs can soak up idle time while many users perform file editing, program development or data entry.

Productivity: A TSX-Plus™ facility known as "virtual lines" allows a single user to control several tasks from a single terminal. TSX-Plus™ allows the same machine to simultaneously support production use, program development and real-time control.

Real-time support: TSX-Plus™ provides a real-time program support facility that allows multiple real-time programs to be run concurrently with normal time-sharing operations. Real-time programs may optionally lock themselves in memory, directly access the I/O page and connect device interrupts to subroutines within the program. The real-time facility can generally handle up to 100 interrupts per second.

Data and Directory Caching: A data and directory caching facility allows the TSX-Plus™ manager to allocate caching buffers to hold in memory a number of directory entries and/or data buffers. This eliminates all disk I/O when requests are issued by programs for entries that are currently in the cache buffers. The information kept in the cache buffers is managed using a least-recently-used (LRU) or most-active algorithm.

Shared run-time systems: TSX-Plus™ allows one or more shared run-time systems or data areas to be mapped into the address space of multiple TSX-Plus™ time-sharing jobs. This saves memory space when multiple users are running the same types of programs (e.g. COBOL-Plus,™ or DBL) and can also be used in situations where programs wish to communicate through a shared memory region.

Additional features: Other features offered by TSX-Plus™ include detached jobs (a batch facility), a transparent line printer spooling system, a logon and usage accounting system, shared file access control, inter-job message packet communication, command files with parameters, the ability for the user to define system commands, and a program performance monitor that will print a histogram showing where a running program is spending most of its time.

Supports 4Mb on the PDP 11/23 Plus.

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CIRCLE NO. 36 ON INQUIRY CARD

SUMMING IT ALL UP

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MULTITRONICS

CIRCLE NO. 37 ON INQUIRY CARD

Dataram goes to extremes to satisfy LSI-11 users.

	DATARAM B23 PLUS	PDP-11/23 PLUS	DATARAM M23	PDP-11/24	DATARAM W23
CHASSIS	5¼" Front loading	5¼" Front loading	5¼" Rear loading	5¼" Side loading or 10½" Top loading	10½" Top loading with 80 MB Winchester
BACKPLANE	8 x 4	9 x 4	9 x 6	9 x 6	9 x 6
I/O MAPPING	None	None	Q-MAP	KT24	Q-MAP
BUS	22-bit Q-BUS	22-bit Q-BUS	22-bit Q-BUS and 18-bit Q-BUS	22-bit extended UNIBUS (EUB) & 18-bit UNIBUS	22-bit Q-BUS and 18-bit Q-BUS
MEMORY & PERIPHERAL SUPPORT	Up to 4.0MB, but limited to 256KB when using peripherals other than RL01/RL02 or RX01		Up to 4.0MB. No basic limitation on peripherals.		
PRICING	B23, M23, and W23 are approximately 35% less than comparable DEC systems in 1.0MB configurations. Additional 1.0MB memory modules from Dataram are about 40% less than DEC's equivalent 1.0MB memory. Contact us for actual price comparisons.				

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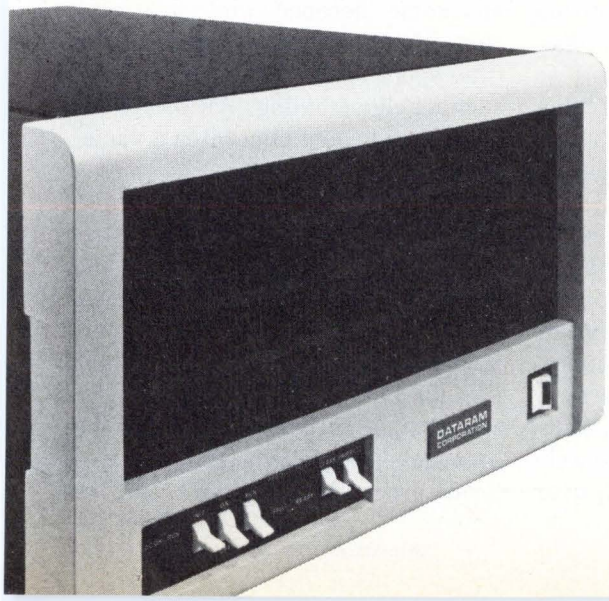
From Q-BUS Pricing to UNIBUS Performance



From top to bottom, chart the range of LSI-11 system performance you get from Dataram...and only Dataram.

It starts with our low-end B23 PLUS Q-BUS system at lower (much lower!) than DEC prices. And continues with high-end M23 and W23 Q-BUS systems that use Dataram's innovative Q-MAP™ I/O mapping module to generate a separate 18-bit bus from the LSI-11/23's 22-bit bus. Allowing you to put 4.0MB of memory on the 22-bit bus while interfacing your high-performance peripherals (RM02, TM11, RX02 and more) to the 18-bit bus. Giving you much more performance than provided by the PDP-11/23 PLUS, which supports only the RL01/RL02 and RX01 on its 22-bit bus.

It's possible, because Dataram's Q-MAP duplicates the functions of DEC's KT24 — which exists only in UNIBUS minicomputers from DEC — enabling Dataram's 4.0MB M23 and W23 minicomputers to be completely compatible with RSX11-M, RSX11-M PLUS, RSTS, UNIX and any other operating system which supports KT24 memory management.

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CIRCLE NO. 38 ON INQUIRY CARD

Epson launches first assault on U.S. microcomputer market

Epson America, Inc., which skyrocketed to a dominant position in the U.S. low-end printer market with products supplied by its Japanese parent, the Seiko conglomerate, is launching its first major product for the U.S. systems market this month. The launch vehicle is a Zilog Z80-based personal computer whose success may be largely determined by the public's reaction to proprietary software tools developed by an Epson affiliate company, Rising Star Industries.

Rising Star president Chris Rutkowski describes the Valdocs software (for valuable documents) as a "user environment." He claims the system has the tools necessary for an inexperienced user to operate and a nontechnical salesperson to sell the computer. Ron Ockander, Epson national sales manager, expects to see Valdocs installed on 80 percent of Epson computers. (The company also offers a CP/M-only version for sophisticated users.) Epson's ambitions for its microcomputer are high—the company wants to become one of the top five personal-computer suppliers in the U.S.

The QX-10 system is based on a 4-MHz Z80 with 128K bytes of RAM, expandable to 256K bytes on the same board. A separate 128K bytes of RAM is dedicated to the Nippon Electric Co. 7220 graphics microprocessor, which is programmed to produce 640 × 120 bit-mapped graphics on a 4-bit plane. Initial disk storage is on two quarter-height, 320K-byte Epson minifloppies. The desk-top cabinet has five undedicated slots that are likely to be filled with a color display controller, a local-area-network controller, a plug-in modem and an auxiliary port, Rutkowski says.

The microcomputer will be sold with the CPU enclosure, a 12-in. display, built-in floppies, a detachable proprietary keyboard, Valdocs, CP/M, FORTRAN, Pascal and COBOL for less than $3000. A CP/M-only version will be offered at a reduced price.

Ockander emphasizes that the major market will be first-time users for whom Valdocs is said to provide a complete, usable package. "I think Osborne Computer Corp. succeeded not because of its portability, but because of the completeness in software. Valdocs has that same concept of completeness," Ockander claims, adding that Valdocs is designed to offer users comprehensive personal-computing facilities without the need to master a variety of programs. Valdocs is machine specific, and Epson has no plans to make it transportable, Rutkowski notes.

Some observers think Epson may have its hands full trying to sell a product that embodies the heresy of a proprietary software system. Byte Industries president David Pava says, "Standardization is the way to go, not unique operating systems." The chances for a product based on proprietary software to succeed in today's market are "slim to none," he says.

Valdocs is built around a consistent user interface, both through screen menus and dedicated function keys on Epson's proprietary keyboard. Rising Star is proposing the keyboard as a standard interface, dubbed the Human Applications Standard Computer Interface.

The HASCI keyboard has predefined function keys that, Rutkowski says, anticipate any computer application. In addition to a typewriter keyboard, it has a cluster of system controls with keys for "stop," "help," "copy disk" and "undo." Another cluster handles file functions, a third is for selecting application type, and a fourth is for selecting typestyle. Two separate clusters are for data-entry/calculator modes and cursor-control/text-editing functions.

Rutkowski claims that, between the keyboard and the software, the QX-10 supplies a consistent set of tools for manipulating textual, numerical, graphical and temporal data. This translates into facilities for word processing, graphics, appointments scheduling, file management and electronic mail.

The guiding principle behind Valdocs is that every symbol is manipulated on a rectilinear field—the screen representation of a sheet of paper. The Valdocs filing system organizes data sequentially: as documents are created on the system, they are automatically time-dated and can be labeled with a title of as many as eight words. Retrieval can be by date of creation or by a user-selected keyboard index. Records can also be searched alphabetically.

Another built-in feature is an automatic appointment book, which maintains a list of things to do, an electronic notepad and an event timer that automatically records the time spent on tasks for applications such as client billing. An electronic drawing package generates a variety of charts from data.

Rutkowski plans to upgrade Valdocs with enhancements that will be supplied without additional licensing charges to current users. He claims that, within a year, Valdocs will have two to three times its current functionality without any change in pricing. One of the first enhancements scheduled is a forms-processing language said to

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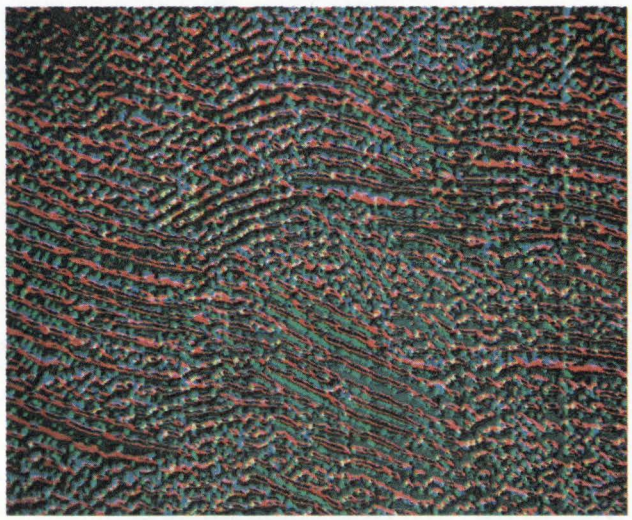

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CIRCLE NO. 39 ON INQUIRY CARD

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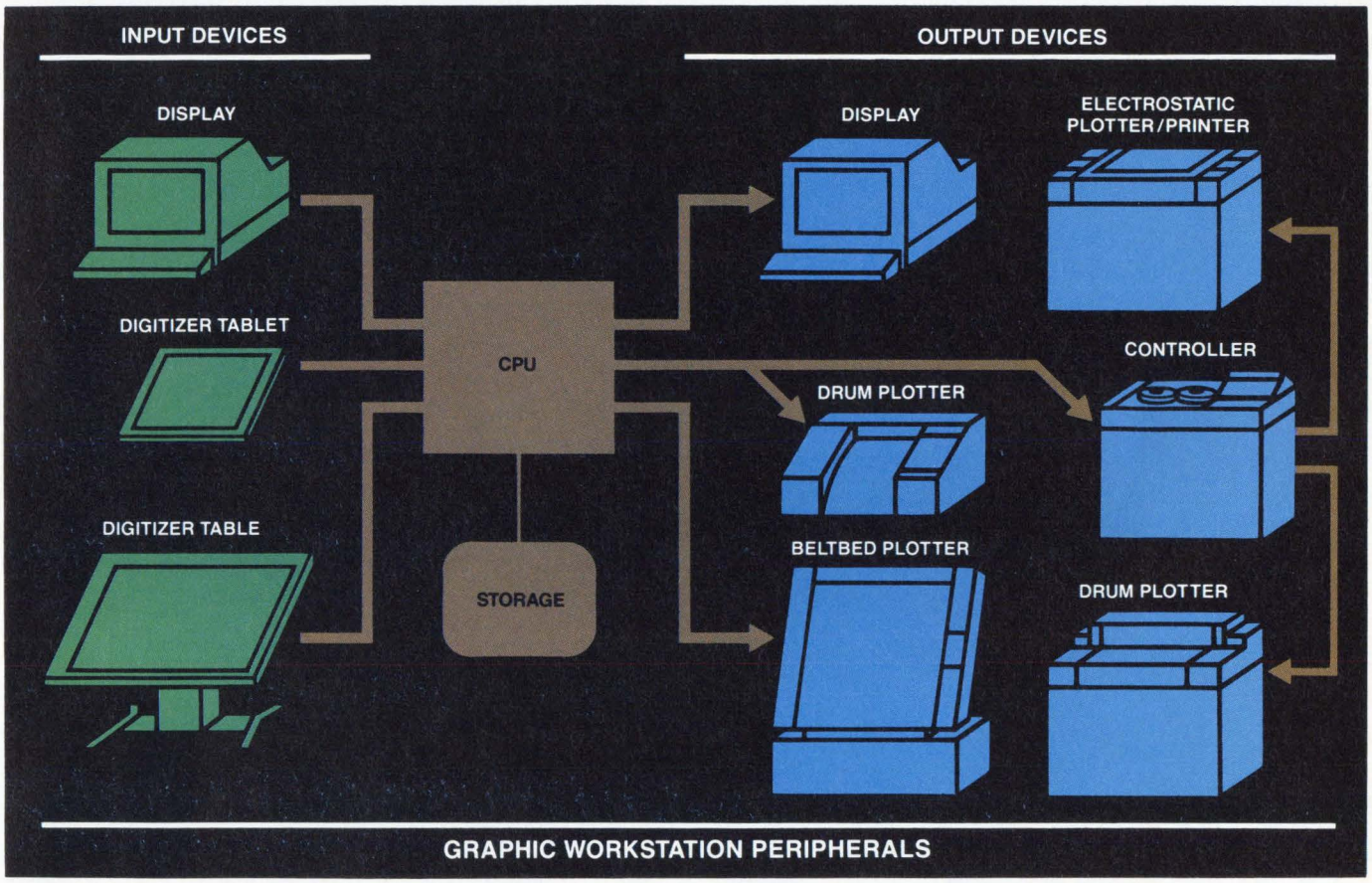

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provide database reporting in a spread-sheet format and support conventional spread-sheet forecasting. The enhancement is due during the first quarter of next year.

The marketing effort for the QX-10 in the U.S. is Epson America's responsibility. Ockander explains that Epson's move last spring to discontinue its 16 independent distributors and to replace them with 12 Epson-owned regional distributors was partially intended to lay the groundwork for QX-10 marketing. "We knew we would need more technical support than we could ask of our independent distributors," he says. A full package of dealer support capabilities for Epson dealers will include technical assistance, cooperative advertising, national advertising/public relations, training and local service with spares stocking.

More significantly, Epson plans to finance dealer inventory, allowing retailers to postpone payments to Epson until systems are sold. Ockander says time limits will be applied to the inventory financing, but declines to define the guidelines. He says the dealers will probably be able to offer on-site service through RCA Data Services, which handles Epson printers, but adds that a contract for the QX-10 has not been signed.

The company plans to market the product through all the traditional personal-computer channels, but at press time, no contracts had been signed with any retail chains. He says Epson does not plan direct marketing to OEMs or major end users.

Alternate channels for the QX-10 are department stores and independent office-equipment dealers, a group approached by many small systems vendors, but whose members have been slow to develop computer expertise. "When Valdocs is completely operable, we'll go to the National Office Machines Dealers Association convention," Ockander says, adding that he expects to be there next summer.

Epson may be forced to develop nontraditional channels for its computers, says an unidentified hardware distributor. He asserts that former "dealers may be reluctant to take on new Epson products because of past differences between Epson and some distributors and Epson's forming its own distributorships."

Ralph Finley, vice president of the Peripherals group at market consulting firm Dataquest, Inc., says Epson's distribution policies have hurt the company. "As Epson reorganized its distribution channel, its former distributors have gone over to Okidata and other competitors with a vengeance," Finley says. He adds, however, that Epson's resulting drop in market share has not been "all that dramatic" thanks to OEM contracts with IBM Corp., Hewlett-Packard Co. and others.

—Geoff Lewis

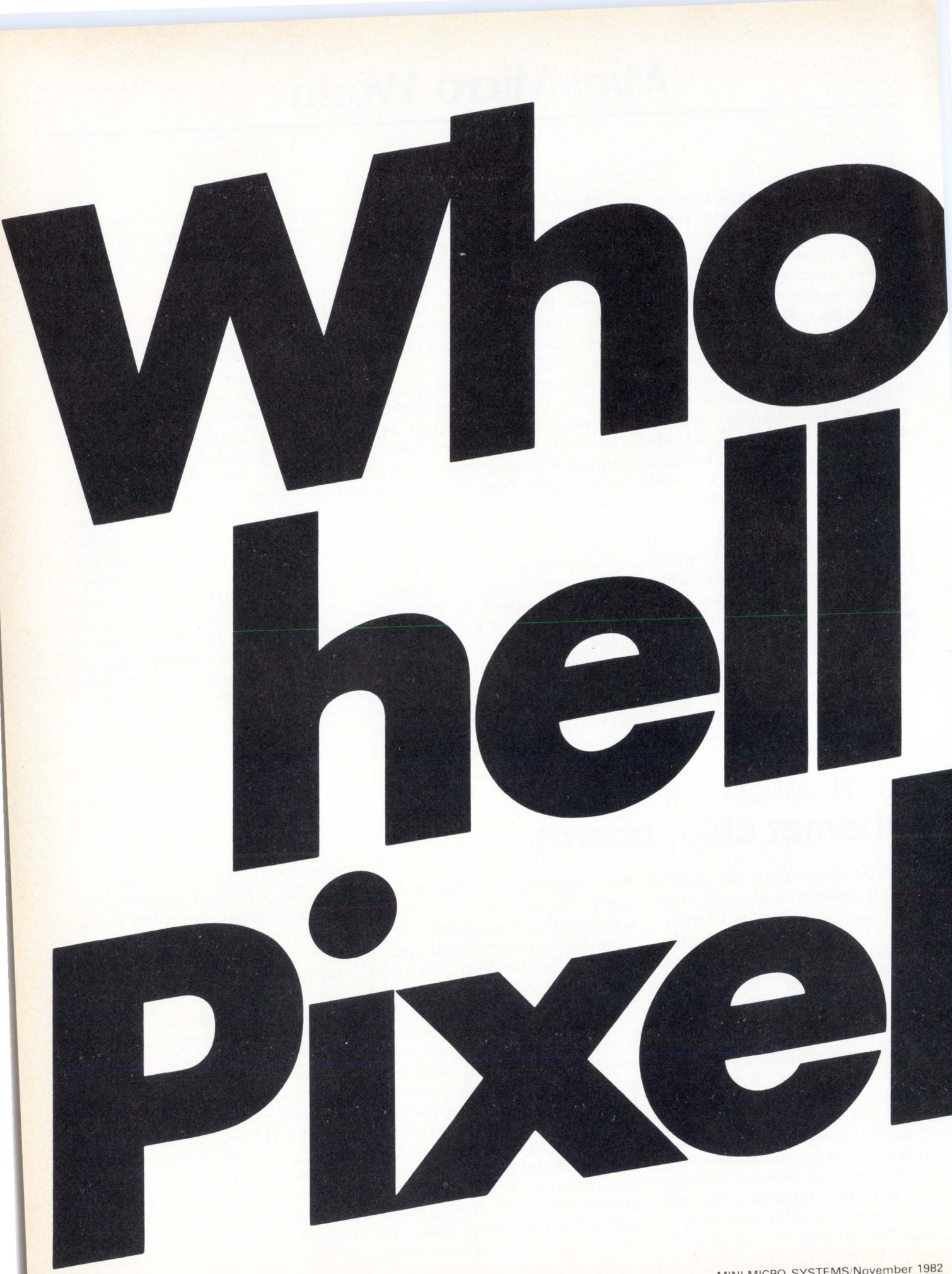
Joint effort turns out Ethernet chip, boards

A VLSI device from two-year-old Seeq Technology, Inc., could signal the imminent availability of affordable Ethernet local-area network interfaces. Called the EDLC 8001 and developed by the San Jose, Calif.-based Seeq and Ethernet controller-board builder 3Com Corp., Mountain View, Calif., the device is said to handle all link layer (Ethernet Level 2) functions. It operates under carrier sense multiple access with collision detection (CSMA/CD), the protocol established by Xerox Corp., which allows a node to be linked anywhere in a network.

Seeq's 8001, reportedly the first such component to be marketed, is expected to bring down the price of Ethernet interfaces. This is especially important in personal-computer-based networks. Other VLSI Ethernet components, slated for introduction over the next several months from a variety of sources, promise to do the same.

A two-chip set is expected soon from Intel Corp., which says volume production could start early next year. Mostek Corp. and Advanced Micro Devices, Inc., are reportedly developing multi-chip Ethernet components based on the specifications for Digital Equipment Corp.'s local-area-network controller for Ethernet (LANCE). Network systems house Ungermann-Bass, Inc., working with Japanese semiconductor maker Fujitsu, Ltd., is also expected to introduce a chip set in early 1983.

Seeq officials say the function performed by the 8001 represents about 60 percent of the cost of an Ethernet system. According to the company, of the remaining 40 percent, 30 percent lies in the encoder/decoder function, and 10 percent is in the transceiver. Comparing available Ethernet controller boards performing the functions of the 8001, an encoder/decoder and a transceiver, Seeq executives predict new hardware incorporating the 8001 could sell for one-third the price of the current hardware. That's about $1000 compared with today's price of $3000. By 1984, as production processes for the 8001 improve, the price of such a board could drop by as much as 90 percent, Seeq says.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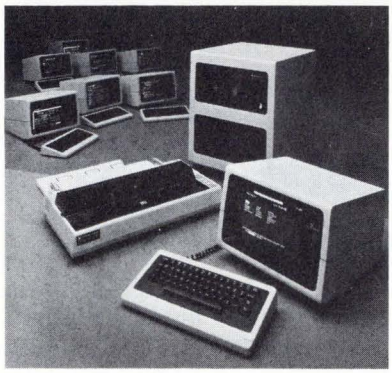

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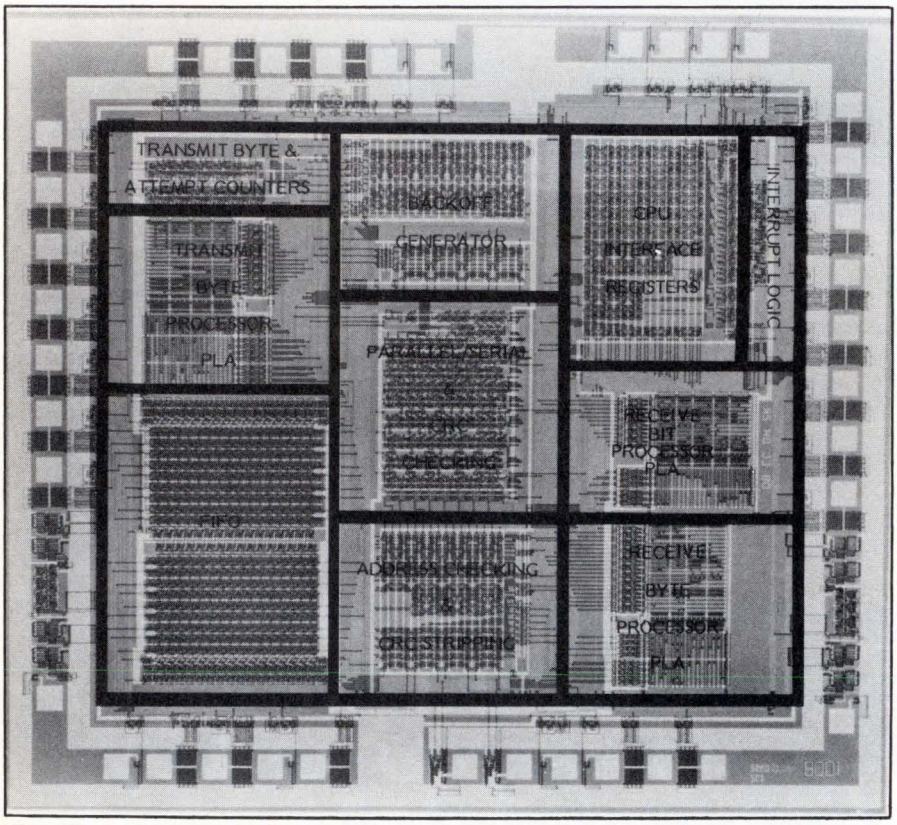

The silicon structures of Seeq's Ethernet data link controller *(EDLC) were generated by the device's logical functions description: it was laid out on the chip, with each function in its logical processing order, starting in the lower left corner and working counterclockwise. This led one observer to dub the device a "flowchart in silicon."*

The 8001 now sells for $135 in quantities of 100, and Seeq says the price could be $20 in a few years.

Co-developer 3Com says the 8001 could replace as many as 60 components performing functions similar to those handled by one 40-pin Seeq chip. 3Com will use the chip in its EtherSeries controllers. The first board, an IBM Corp. PC-compatible controller, is expected to be available next month. Price is $950 including software. 3Com is said to be planning similar hardware for Intel Multibus-compatible systems.

The 10-MHz 8001 is divided into three sections: the transmit processor, the receive processor and the CPU interface. It is compatible with any microprocessor and bus structure, the company points out.

Both transmit and receive functions are subdivided into bit- and byte-processing modules. These handle operations such as serial-to-parallel data conversion, bit- and byte-level error detection and reporting, address matching and collision avoidance and contention resolution. Two asynchronous, 16-byte, FIFO buffers handle all parallel data communications within the chip.

Seeq officials indicate that the company is working on other chips to add to the family started with the 8001. An encoder/decoder is in the works now and could be ready next year.

—Larry Lettieri

Ampex plans drives with thin-film media

A line of high-capacity OEM Winchesters incorporating Ampex Corp.'s Alar brand of thin-film media will be available in evaluation versions early next year from that company. The adoption of thin-film media reverses the company's previous reliance on conventional oxide-coated media from outside suppliers, and marks the first in-house use of the thin-film disks that the Redwood, Calif., company has been selling to outside drive vendors for a number of years.

The decision by Ampex to switch to its own line of thin-film media has been anticipated for some time, given the company's position as the leading OEM supplier of thin-film disks. "Conventional oxide-coated media is being pushed to the limits of its performance," explains Chua Lin, chief engineer for disk engineering at the company's Memory Products Division in Cupertino, Calif.

The thin-film additions to the company's product line will initially double Ampex's Winchester capacities across the board. The first thin-film iteration of its 5¼-in. Pyxis drives, for example, will hit 50M bytes, Lin says. The 8-in. Scorpio line will offer capacities in the 160M-byte range, making it a direct competitor to the high-capacity drives proposed by companies such as Micropolis Corp. and Control Data Corp. Capacities on Ampex's announced 14-in. Capricorn drives (MMS, September, 1981, p. 48) could reach 660M bytes with the addition of thin-film media.

Ultimately, Lin says, the compa-

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Office Memo

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Date: November 10, 1982

From: Tom Donohue, President

Subject: Computer recommendations

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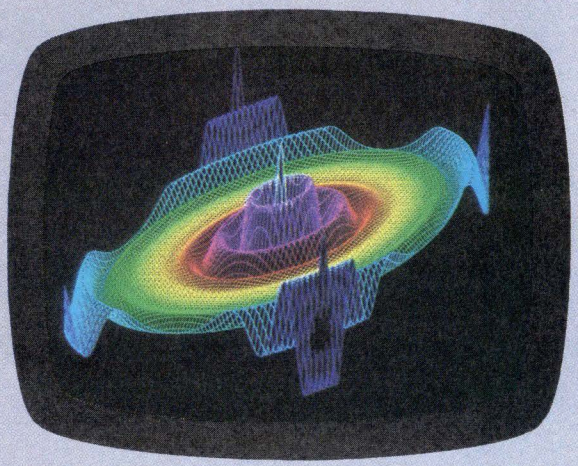

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ny could backtrack and phase out existing drives based on oxide-coated media. Yet to be addressed is the impact such a decision would have on existing controller design: if bit densities are doubled, transfer rates will correspondingly increase.

All thin-film media Ampex drives will incorporate manganese-zinc ferrite mini-Winchester or composite heads mounted on 3370-style flextures (head suspensions), giving the company the option to incorporate thin-film read/write heads for even higher linear densities later, Lin explains. Further increases in linear densities and, hence, drive capacities will result from a proprietary thin-film process designed to handle vertical, or perpendicular, recording techniques, he adds. "Prototype versions of drives using this media in conjunction with vertical recording will be available from Ampex in 1984," he says, "and I'll need this media in volume in 1985."

To meet its in-house needs, as well as the anticipated demand for thin-film media from outside vendors of OEM Winchesters, Ampex is planning a major plant expansion in the San Francisco Bay Area and intends to have an automated 50,000-sq.-ft. media-production facility on-line in San Jose, Calif. Pilot production at the plant is set for the first quarter of next year, with the first line scheduled to be up and running by May. The plant will handle 5¼- and 8-in. media; 14-in. disks will continue to be manufactured at the company's neighboring Sunnyvale plant. As a result, says Ed Fleming, general manager of the company's Materials and Devices Group now headquartered at that plant, disk volume in dollars will triple between this year and next, and will triple again by 1986. Fleming does not disclose exactly how much money was involved in media sales, but he does say that his

MINIBITS

SEAGATE LICENSES SONY DRIVE

Seagate Technology Corp.'s recent decision to second-source Sony's Corp.'s 3½-in. floppy disk drive may lead early next year to a 3½-in. Winchester upgrade based on the same form factor, say sources close to the Scotts Valley, Calif., company. At the same time, citing a lack of market definition, the company has decided to retreat from the high-capacity, small-Winchester business, and withdraw its proposed ST-538, a 38M-byte, 5¼-in. device initially equipped with thin-film read/write heads (MMS, November, 1981, p. 46). Seagate, which has never manufactured floppy disk drives, may set up a separate company to handle the 3½-in. licensed device, and sees the Sony agreement as a way of promoting media standards for small diskette drives. Tandon Corp., Chatsworth, Calif., has already announced drives using Sony's plastic-jacketed diskettes (MMS, October, p. 00). Pricing and availability of the Seagate diskette drive will be set by year-end.

RACAL-MILGO UNVEILS LSI-BASED MODEM

Following 16 months of design and development of three custom chips, Racal-Milgo, Miami, has introduced a 4800-bps modem based on its new LSI components. The entire Omnimode 48 modem resides on one PC card, a configuration made possible through the use of the new arithmetic-logic unit, memory-management unit and interface analog/digital ICs. Already in production from multiple sources, the three chips will be incorporated in future Racal-Milgo datacomm products, company sources say. Sporting a menu-driven intelligent front panel, the Omnimode 48 displays modem, line and interface status; network configuration information; and the results of various diagnostic tests. With all protocol information stored in nonvolatile memory, the modem eliminates the use of internal hardware straps. Two board-level options for the Omnimode 48 are remote modem control and multiport. RMC lets a central-site Omnimode 48 control 32 local modems and more than 100 remote modems, without another external controller. The Multiport option is available in two- and four-port versions, and lets a single Omnimode 48 handle several channels, whose aggregate data rates can't exceed 4800 bps. Single-unit price for the Omnimode 48, available in desk-top and rack-mount versions, is $3600.

BURROUGHS INTRODUCES ENTRY-LEVEL COMPUTER

Burroughs Corp.'s new entry-level system in its medium- to large-scale computer line, the B 5920, can be used stand-alone or remotely as part of a distributed-processing network. With prices starting at $180,000, the B 5920 offers 3.1M bytes of main memory using 64K-bit chips. The processor, memory and I/O subsystem are housed in a cabinet measuring 44 × 45 × 29 in., a 69-percent reduction in floor space from previously available B 5900 systems. The price includes an independent front-end processor, which fits in the cabinet, for managing data-communication networks. All application, database and system software runs unmodified on a single-processor B 5920 or a multiprocessor B 7800, the company says. A single-processor B 5920 can be field-upgraded to a four-processor B 5900 computer system with as much as 15.5M bytes of main memory.

Burroughs's LINC fifth-generation language compiler for the B 5920 that speeds application-system development will be available early next year. Customer deliveries of the B 5920 will begin in the fourth quarter of 1982.

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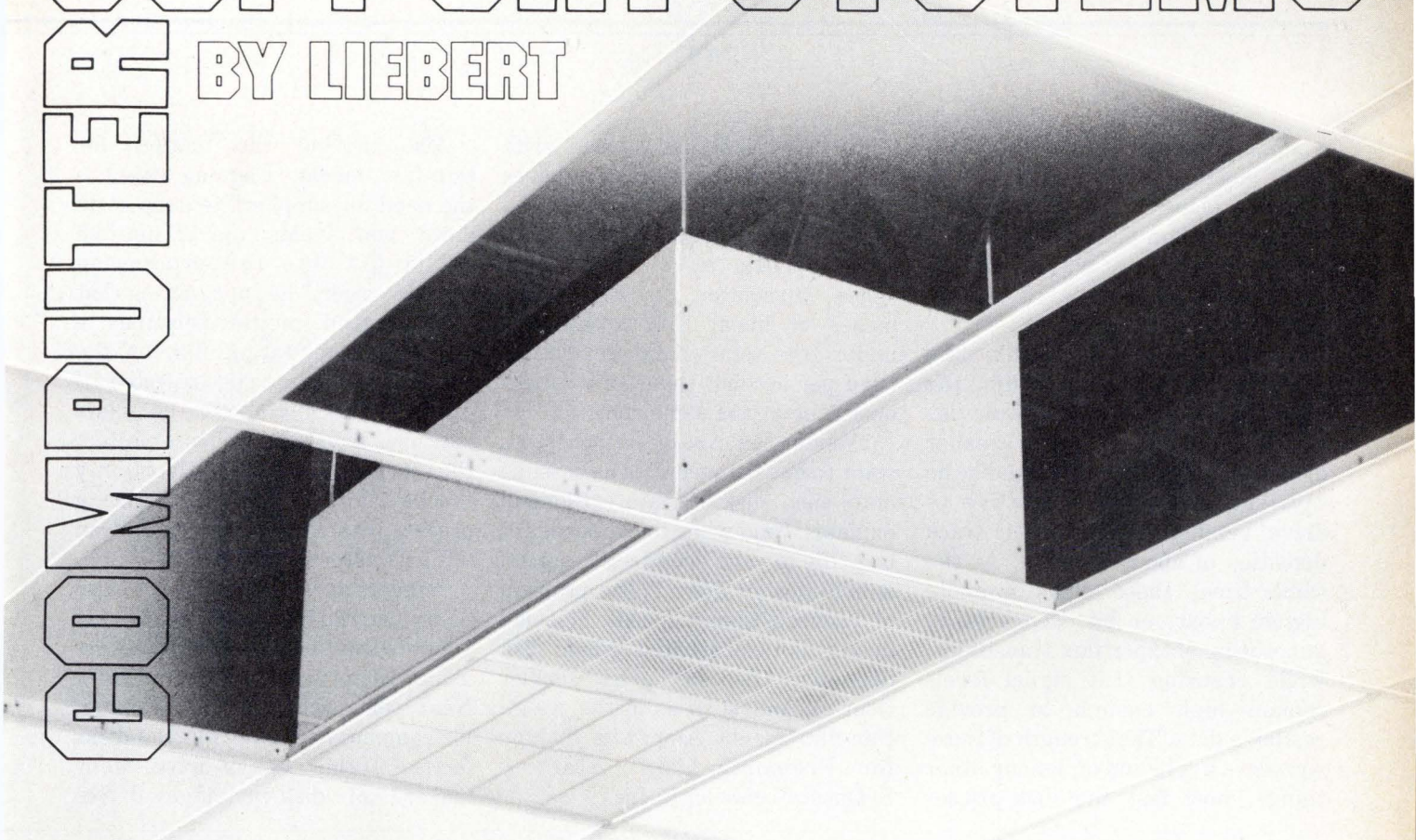

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company shipped 55,000 disks this year, mostly for 5¼-in. drives. By 1986, he plans to ship more than 1 million thin-film platters, an unspecified percentage of which could be designed to handle even higher capacity vertical recording.

Driving the market for this class of media, Fleming says, will be the need to increase memory capacities radically in drives with smaller diameter disks. Thin-film media, he says, is particularly attractive to drive vendors interested in track densities of about 1000 tpi. At the same time, these disks promote higher linear, or bit, densities by generating sharper flux transitions, while ensuring that signal levels remain high enough to provide readable data. The strength of these signals is a function of, among other things, how fast the disk passes under the stationary read/write head. The 14-in. diameter drives operating at the 3600-rpm speed typical of Winchester devices of all sizes, operate at a faster linear speed (measured in how many inches of linear disk space pass under the stationary read/write head per second) than 5¼-in. disks operating at the same rpm.

"Vendors of 5¼-in. Winchesters want to get as much data as possible onto each disk surface," Fleming explains, "and when linear speeds of the disks are reduced, signal amplitudes go down." The problem of reduced linear speeds in small drives is exacerbated when disk diameters become even smaller than 5¼ in., such as in the 3.9-in. thin-film media Ampex is making for Fremont, Calif., start-up SyQuest Technology, Inc.

Also driving the market for thin-film media, Fleming says, is the need for suppliers to keep costs down and yields up. "Thin-film media fits into the production process easier," he says, noting that oxide-coated media requires a protective lubricating film on the surface and must be rejected if touched. Thin-film media, he points out, uses a metallic finish to protect the surface and, if inadvertently touched during the manufacturing process, can simply be wiped clean with a fluorocarbon solvent.

Interest in thin-film media is also being spurred by the potential many vendors see for 5¼-in. Winchesters using removable disk cartridges. Next year, according to Fleming, his company will ship 150,000 disks for use in this class of drive. Many makers of disk-cartridge drives

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plan to use thin-film media rather than oxide-coated disks because of its durability, and because of its ability to withstand damage in case the head and disk slap together. Many vendors also feel that, compared to conventional oxide-coated disks, thin-film media will continue to operate more reliably in the more open environments dictated by the requirement for removability.

Ampex has taken the cover off one of its 5¼-in. rigid disk drives, put one of its Alar thin-film disks into it and has been running it in a completely open, unprotected environment, Fleming adds. "This drive has been running in our lab for months," he says. "We have more than 4000 hours on it so far."

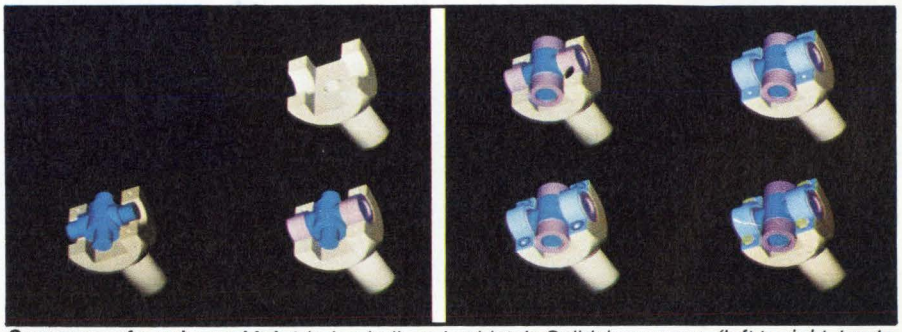
—John Trifari

Solidview pegged as advance in rapid solids modeling

Lexidata Corp.'s Solidview, a computer display system using technology that reduces the time needed to generate and display a solid image, may prove as significant as color raster technology has to computer graphics, say prominent industry participants.

"Solidview is going to have a very dramatic impact," says Dr. Patrick

Continued on page 88



Sequence of a universal joint *being built on Lexidata's Solidview screen (left to right, top to bottom).*

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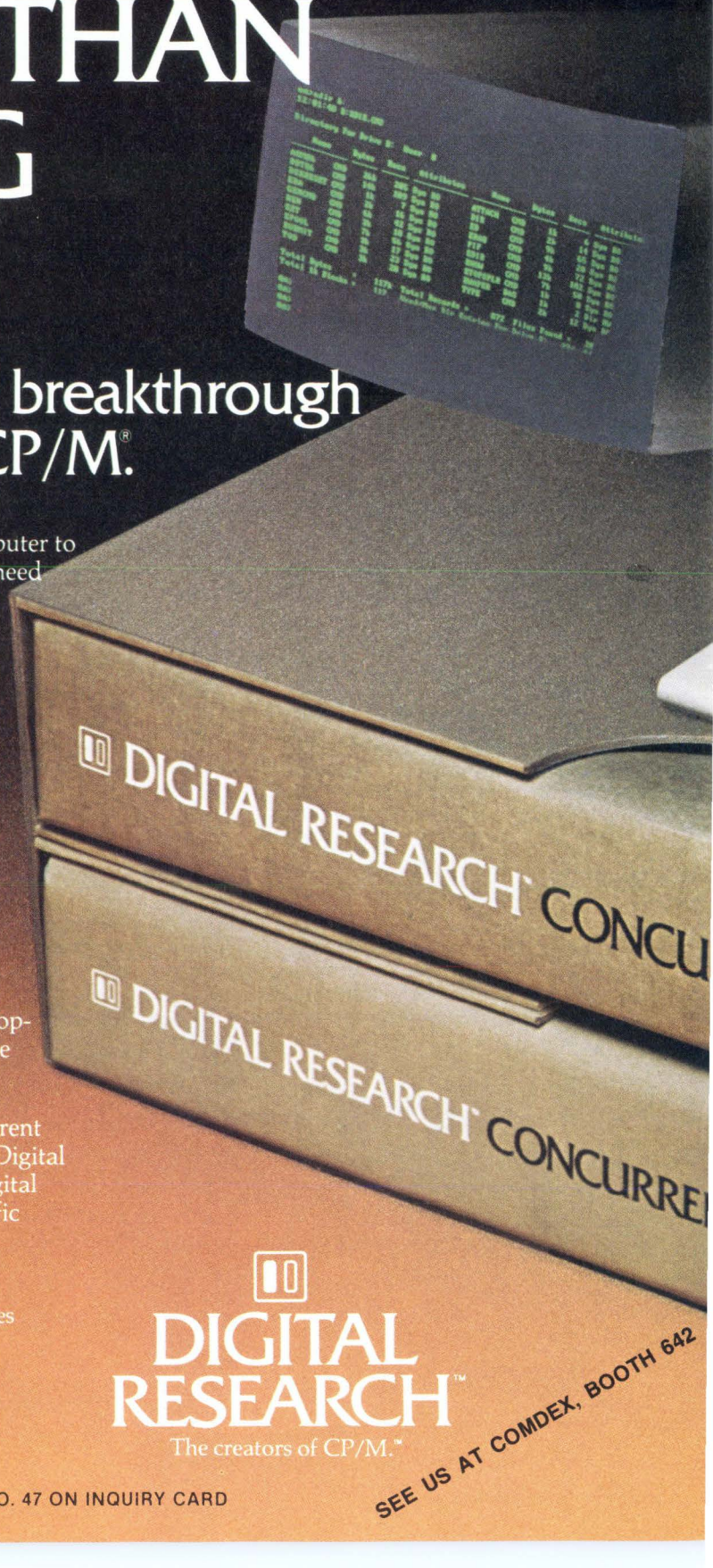

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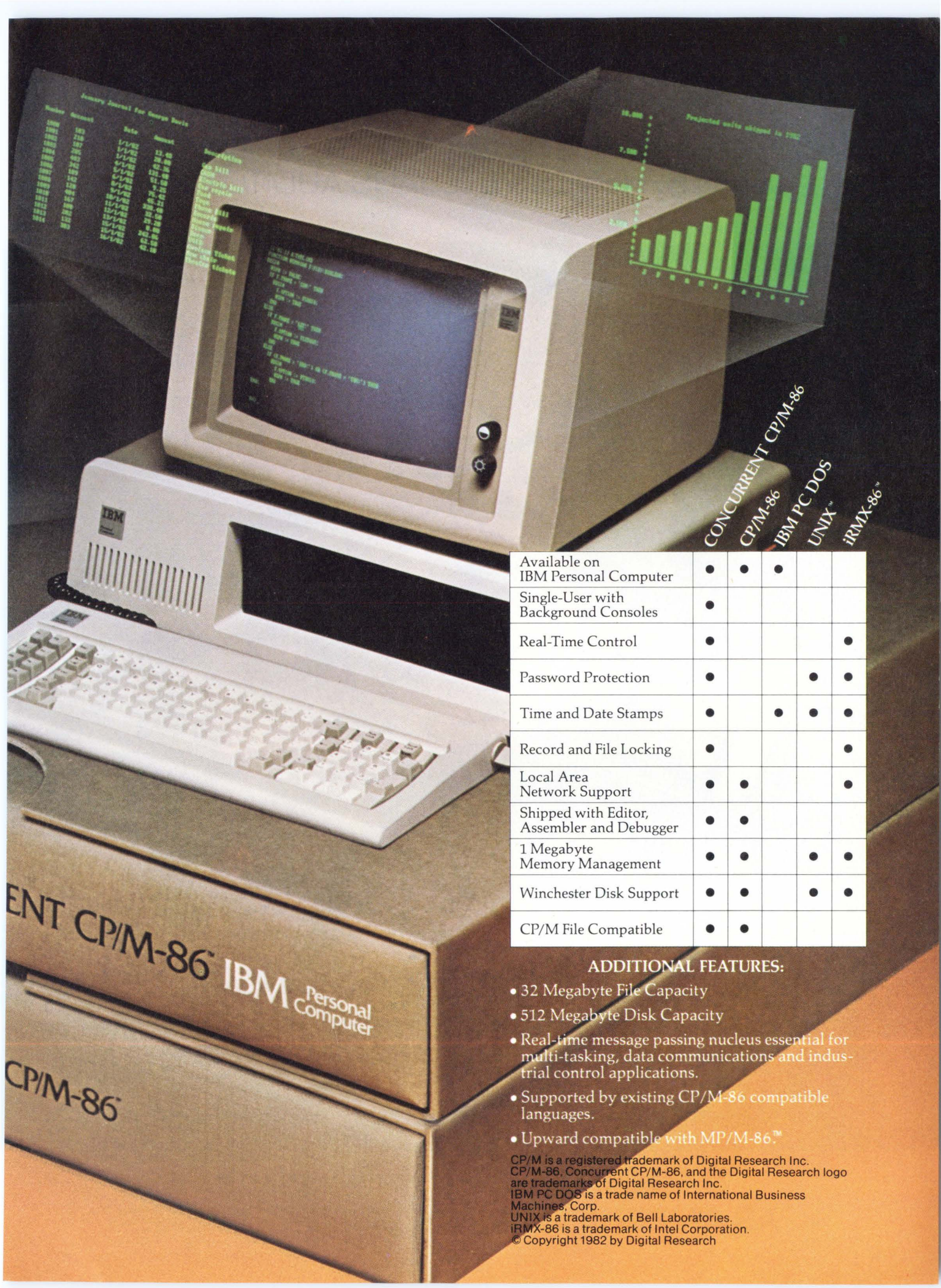

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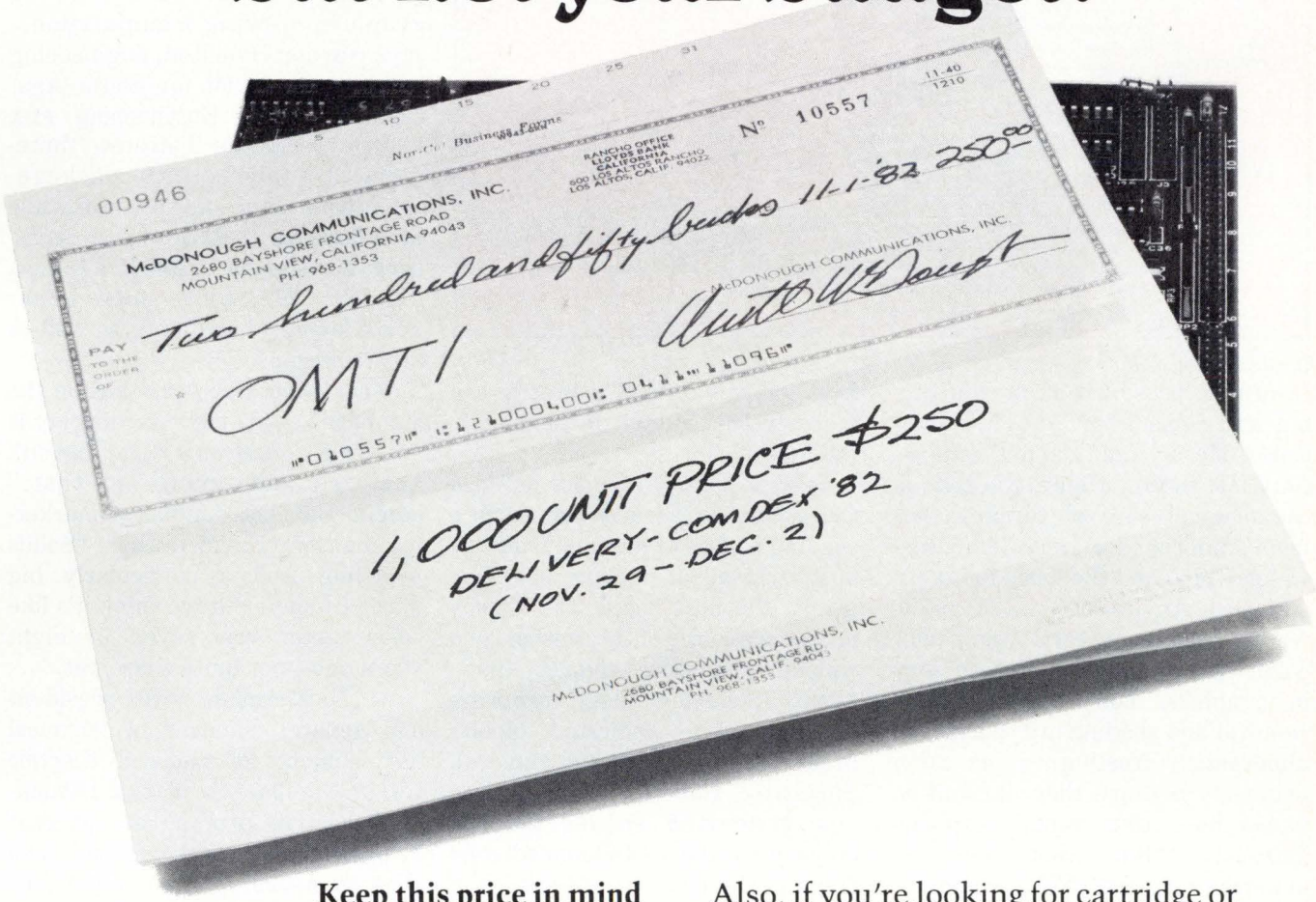

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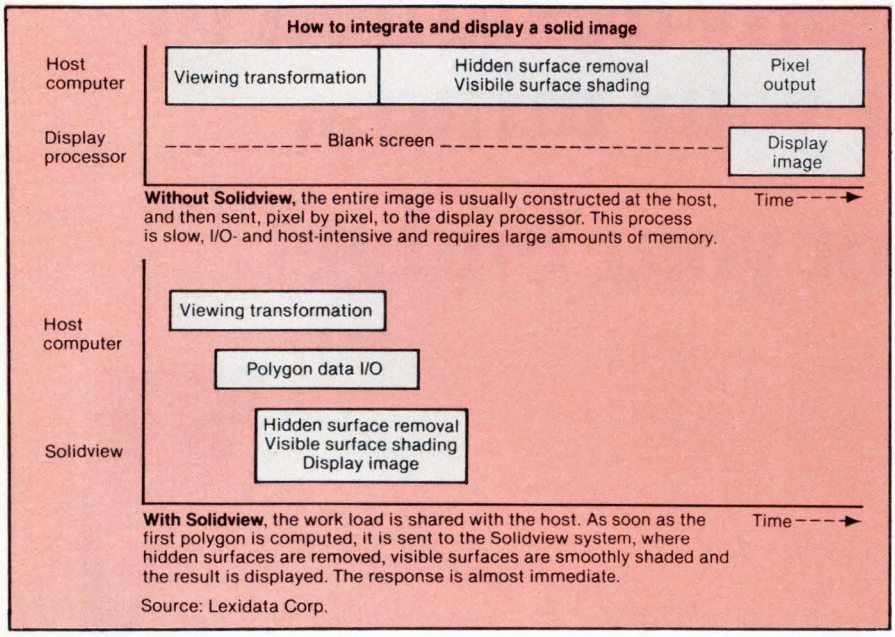


Continued from page 83

Hanratty, president of Manufacturing and Consulting Services, Inc., Costa Mesa, Calif., and a seminal CAD/CAM figure. Hanratty's code is the original core of turnkey CAD from Applicon, Inc., and Computervision Corp. and the basis for MCS's advanced Anvil-4000 CAD/CAM software. "Just as several years ago, color was thought to be unnecessary in graphics, now, hidden-surface removal and shading are considered unnecessary frosting on the cake, primarily because they demand so much host CPU time," explains Hanratty. "But when you can generate complex, shaded images of solid objects in seconds, that capability will become as mandatory as color is today," he says. "Solidview is the first step."

Generation of a solid image was previously done in a host CPU, which transforms and clips an object into a viewing volume, removes hidden surfaces and uses a complex shading algorithm to calculate pixel values for each visible surface. When complete, the host sends the object representation as pixel data to the display processor. Finally, the image appears in scan-line order from top to bottom. The process can take several minutes, depending on the host's load.

Solidview's approach is to off-load the hidden-surface removal, surface shading and pixel drawing from the host. Instead of passing individual pixels, the host passes the display image as a series of transformed and clipped geometric figures (polygons). Solidview uses firmware running on a dedicated bipolar processor for hidden-line removal, calculates smooth shading from host-generated shades for the polygon's vertexes and immediately displays the pixel representation of that polygon. Meanwhile, the host concurrently transforms, clips and sends the next polygon in the image. Although complex images require processing of about 5000 polygons, Solidview reportedly completes the image in seconds.

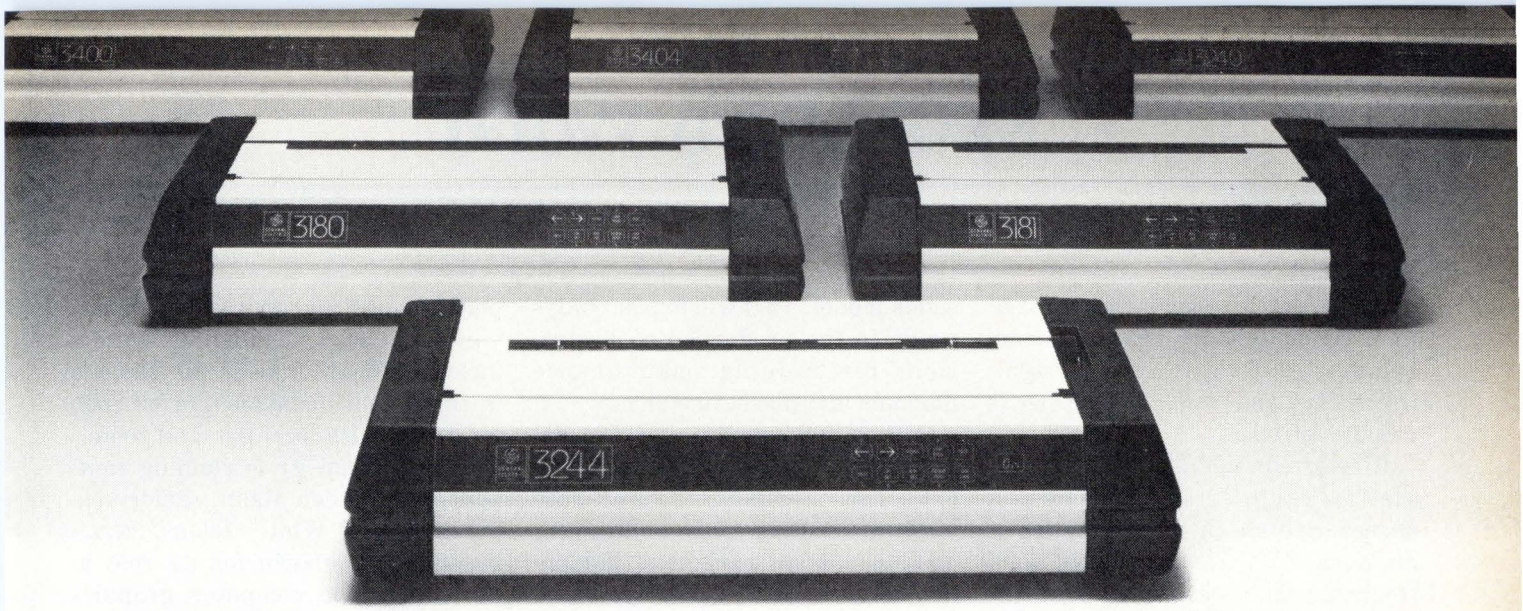
T.Y. Shin, engineer in charge of Solidview's development at Lexidata's Billerica, Mass., facility, explains that the new display system is simply Lexidata's 3400 series 640 × 512 resolution color raster terminal enhanced with extra scratchpad memory, a proprietary bipolar processor and a firmware implementation of essentially the same hidden-line removal and shading algorithms that previously resided in FORTRAN code on the host.

How effective is Solidview in off-loading the host? Solidview will give a CPU savings to a user during graphics viewing manipulations, says Hayden Hamilton, engineering software specialist for Santa Ana, Calif.-based PDA Engineering. PDA is vendor of the Patran-G finite-element-analysis CAD package. Hamilton says minor software modifications to Patran are necessary to support Lexidata's new display. He also notes that Solidview can handle 2D, as well as 3D, commands.

What effect Solidview has on the size of the solids-modeling market is an open question. "We haven't analyzed and quantified that," admits Lexidata's industry marketing manager David Luther. "Solids modeling isn't a particularly big market today. But we think it's like color raster was seven or eight years ago—not quite there yet."

Al Klosterman, vice president and general manager of technical development for General Electric Co. CAE affiliate Structural Dynamics Research Corp., agrees, at least in part: "Solids modeling has been slow to catch on, and a primary problem is the slow speed at which you can do things," he says. "Wire-frame modeling, in comparison, is instantaneous. So I think Solidview will accelerate the acceptance of solids modeling."

The image is not really the key, Klosterman says. He, Hamilton and Hanratty pinpoint the primary benefit of solids modeling as the variety of analyses—stress, aerodynamics, weight distribution and finite element—that can be performed on the mathematical model underlying the object. The dis-



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played image is secondary compared to the functionality that allows an engineer to verify the design's reliability and cost before it is manufactured.

Klosterman points out that Solidview's rapid display allows a designer to check the aesthetics of his work. And, Hanratty says, solid rendering aids design by eliminating confusion that often arises in interpreting wire-frame images.

CAD vendors also cite the advantage of Solidview's easy and rapid generation of high-quality, complex, shaded images from an underlying solids model. This will expand CAD's realm to the production of illustrations for training, maintenance manuals and marketing aids.

Although Solidview gives Lexidata a lead in the graphic presentation of solids, competitors are close behind. Ikonas Corp., Raleigh, N.C., claims to have local hidden-line removal, and San Diego-based GTI Corp. reportedly is developing a polygon-based real-time display that incorporates both local hidden-line removal and smooth shading. Details are not firm, but the unit will probably be higher in both performance and price than Solidview. A basic Solidview system including monitor sells for $29,000 in single-unit quantities, or $37,000 for a unit with local pan and zoom.

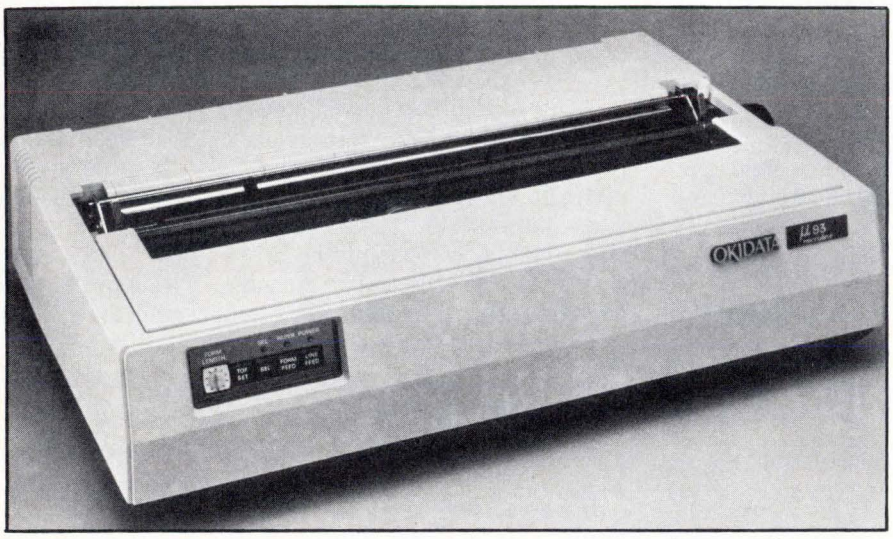
"The technology is running rampant," says Leon Malin, senior vice president of White Plains, N.Y.-based Magi, known for its role in developing the computer graphics used in the movie "Tron." "The next guy is liable to do it faster and cheaper—it won't be long before local solid-object display processing becomes common."

—*Kevin Strehlo*

Okidata printers signal more focused market strategy

Following close on the heels of Okidata's recent decision to discontinue all but modification manufacturing in Mount Laurel, N.J. (MMS, October, p. 00), the company will introduce two additions to the Microline family of 80- to 200-cps dot-matrix printers at the November Comdex show in Las Vegas. Those new products, coupled with the phasing out or replacement of earlier printers, mark Okidata's strategy to expand its printer offerings and address a broader market.

The ML92 and ML93 printers, says vice president of sales and marketing Chet Baffa, will carry a higher price and offer about a 30-percent speed improvement, or 160 cps, over Okidata's low-end Microline offerings, the 120-cps ML82A and ML83A, introduced in August, 1981. They also offer correspondence quality for word-processing output and signal a focused Okidata product and marketing strategy aimed at desk-top computer applications.



The Microline 93 *is one of two dot-matrix printers introduced by Okidata. The ML93, a dual-mode, 132-column printer, prints bidirectionally at 160 and 40 cps in data-processing and correspondence-quality modes, respectively. The dual-mode, 80-column ML92 also prints bidirectionally at 160 and 40 cps in data-processing and correspondence-quality modes, respectively.*

The bidirectional Okidata ML92 and ML93 dot-matrix printers, based on dual 8039 8-bit microcontroller chips from Intel Corp., operate at a maximum of 160 cps. The printers have a dot-addressable graphics resolution of 72 × 72 dpi and a Centronics parallel interface. Other features include proportional spacing, dot- or character-column horizontal positioning and self-diagnostics.

The ML92 narrow-column Microline offers 80 characters per line at 10 cpi, 96 at 12 cpi and 136 at 17.1 cpi. The wide-column ML93 offers 136 characters per line at 10 cpi, 163 at 12 cpi and 233 at 17.1 cpi.

Options include a 200-character buffer and current-loop, RS449, RS422, Centronics HS and 4000-character buffered RS232 interfaces. Production quantities are expected during December or January.

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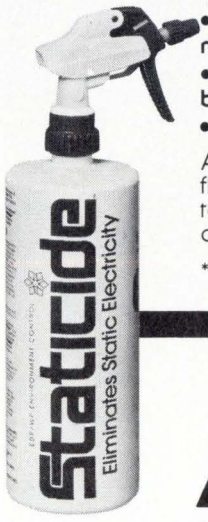

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A key feature of the new printers, says Ralph Mahoney, product manager for Okidata's high-performance ML84 and Pacemark 2350 printers, is all-points-addressable graphics. "The end result is that, with the proper software, you can create high-quality graphs, bar charts, pie charts or other types of pictures," Mahoney says. In addition, a user can duplicate what's on the CRT screen in black-and-white hard copy.

Mahoney also points out the printers' word-processing capabilities. "Word-processing packages such as WordStar and Perfect Writer are widely used with personal and desk-top business computers," he says. "The users of these packages also want high-quality printing for their correspondence." He says printers that lack correspondence-quality output won't find many buyers in the graphics/word-processing markets.

Baffa agrees: "These products evidence the continuing trend toward printers that are more versatile, fully featured and offer higher printing throughput for prices that are within the reach of the small-business owner," he explains.

Most industry observers expect the market for personal-computer printers to soar. Over the next five years, domestic sales of serial character printers for personal computers will increase at an annual rate of 40 percent, says research firm Advanced Resources Development. These printers will account for approximately 80 percent of all serial character printers shipped in the U.S., an ARD report states. Research by Dataquest, Inc., shows that the North American serial-printer market will grow to $2.1 billion by 1986, up from about $1 billion last year.

Okidata's reorganization strategy —phasing out some products and unveiling others—focuses on the company's product charter, intended to appeal to a broad market base. Baffa believes the company is beginning to reach that base. At the low end are the 80-cps ML80 and the 120-cps ML82A and ML83A, which sell for $449, $649 and $995, respectively. The 200-cps ML84 and the 350-cps Pacemark 2350, which retail for $1395 and $1515, respectively, make up the high-end of the line. Baffa says Okidata is trying to keep the pricing competitive on the mid-range 92 and 93. Prices aren't final, but the company plans to

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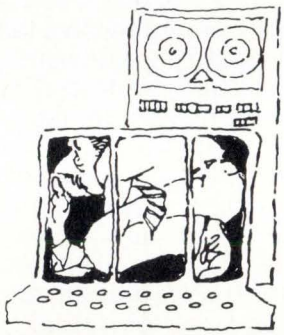

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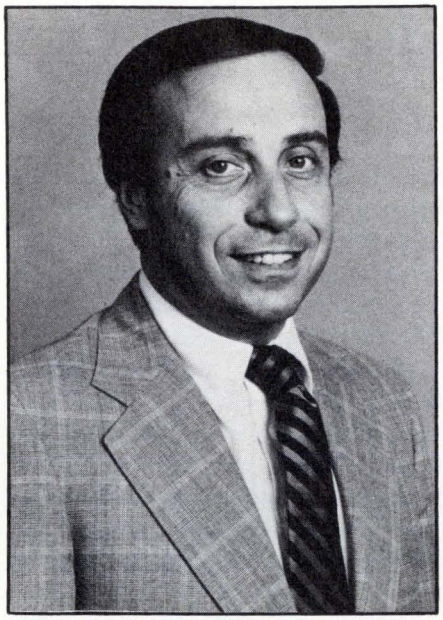

Okidata's vice president of sales and marketing Chet Baffa *says the ML92 and ML93 printers will carry a higher price and offer about a 30-percent speed improvement over the company's low-end ML82A and ML83A offerings.*

retail the 92 for less than $700 and the 93 for $900 to $1200. With the two newcomers, however, Okidata could phase out the 82A and 83A, but not before 1984, says Baffa.

The souped-up 92 and 93 Microlines are also targeted at the low end of the serial impact matrix-printer market, a segment in which Epson is ranked number one by observers. Okidata and other printer manufacturers have set their competitive sights on Epson's 80-cps MX80 at $645, MX80 F/T at $745 and 100-cps MX100 at $995.

C. Itoh's 100-cps ProWriter Series 8500 at $399 is also in the race, as is the Centronics Data Computer Corp. 80- to 100-cps 739, priced at $695 to $795. Centronics's mid-range 200-cps Printstation models 352 and 353 offer some features comparable with the Microlines, but are priced at $1700 to $2400.

Although Okidata's new Microlines may compete with Epson in performance, says one observer, Epson's prices are lower. Baffa feels that the suggested pricing is competitive, but points out that Epson is not the only target at which Okidata and other companies are aiming. "I woudn't like to position ourselves as having paranoia about Epson," Baffa says. "We're out there competing with others very seriously, too. We compete with every printer manufacturer up to 350 cps. We're active in the same market with Epson because they are our largest competitor in the lower end of our product line." —*Nancy Love*

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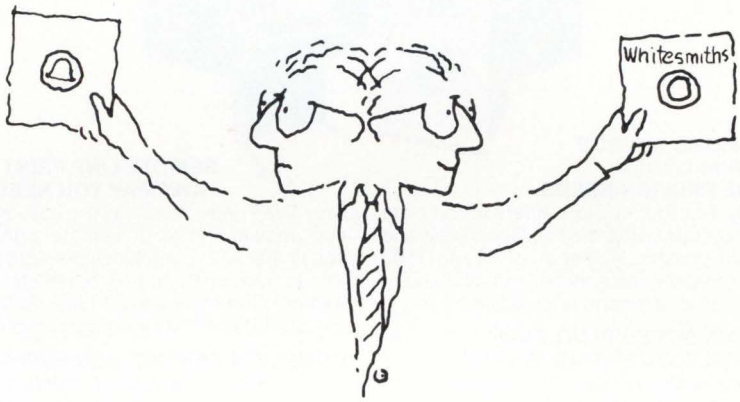

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Multiprocessor, multi-user system runs on VME bus

A multiple-microprocessor-based system that can handle eight to 16 users on the VME backplane bus will be introduced this month at Comdex in Las Vegas and Europe. The VME bus is a 32-bit backplane established one year ago by Motorola, Inc. Deliveries of the hardware are expected to start by the end of the first quarter of next year.

The system is the first product from year-old Victory Computers, Inc., Campbell, Calif., founded by Roger Vass, formerly the vice president of marketing and sales at TeleVideo Systems, Inc.'s computer division and vice president of marketing at Altos Computers, Inc.

Victory is pricing the system in the $10,000 to $20,000 range, Vass says. He indicates that his competition includes hardware from Molecular Computers, Inc., OSM Computers, Inc., and Micromation, Inc. These systems use multiple 8-bit processors to expand the hardware's capabilities as the number of users increases. Vass, however, has based his machine on 16-bit processors.

Further, Vass will market two systems. One uses the MC68000 and is aimed at the industrial-control and robotics markets. The other is based on Intel Corp.'s iAPX 186 and is targeted at general data-processing customers. Both systems run on the VME bus, which attracted Vass because it is becoming a standard. Additionally, he says, "The growth potential (for systems on VME) is good." A 16-bit architecture now on VME can easily be upgraded to 32 bits once these higher performance processors are available, he adds.

Operating-system software for the MC68000-based hardware is Unisoft Corp.'s implementation of Bell Laboratories' UNIX. Version 7 is available, Vass says, but the company is moving to System III.

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CIRCLE NO. 52 ON INQUIRY CARD

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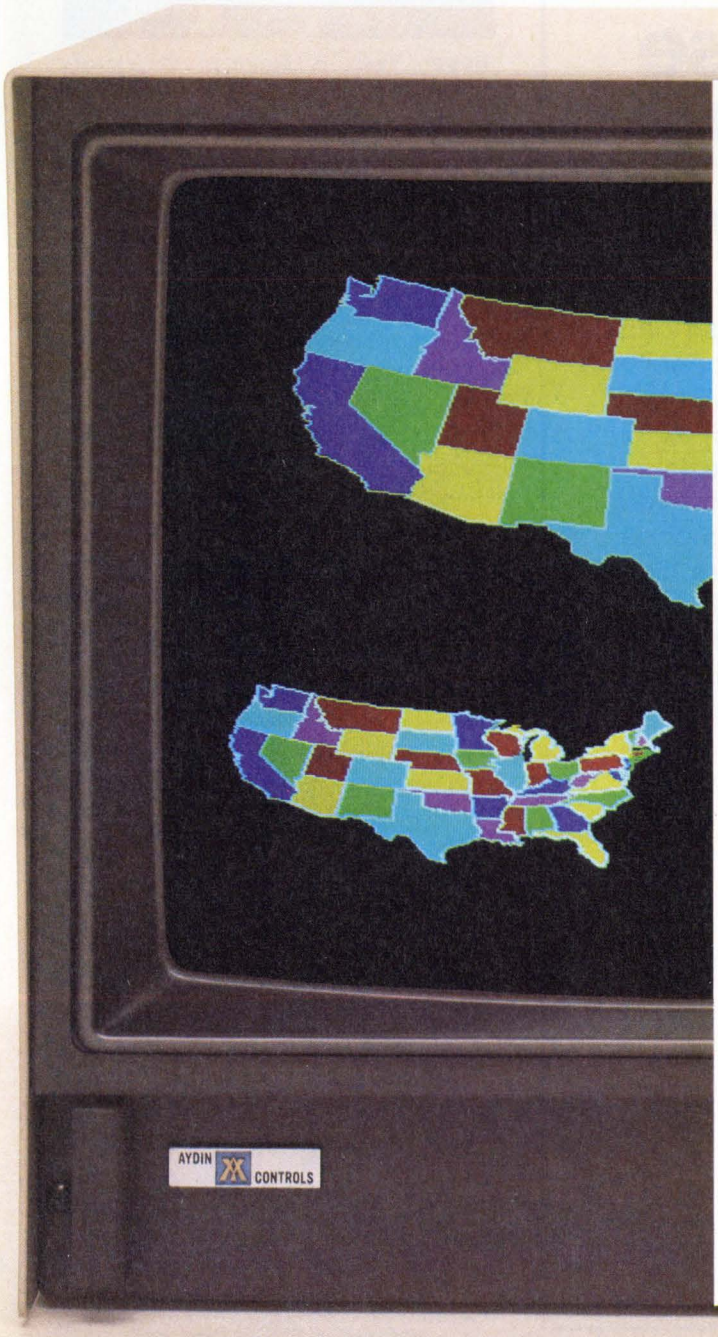
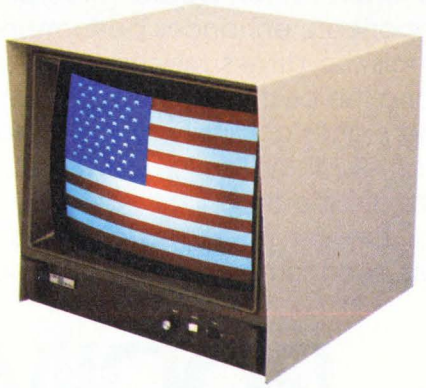


Aydin Controls, a leader in high resolution color display terminals, now manufactures Patriot™, its own in-line gun series of color monitors. The Patriot series will supplement Aydin's well known family of delta and in-line gun monitors.

Patriot's 13-inch Model 8810 and 19-inch Model 8830 both offer the latest state-of-the-art features plus all of the advantages of American technology and manufacturing. Patriot features high video bandwidth, wide horizontal line rates, fixed convergence, excellent high voltage regulation, modular construction, analog or TTL inputs and rack mountability. The Patriot Series can be customized to fit special needs.

Patriot monitors provide outstanding performance at an attractive price coupled with an 18-month OEM warranty; off-the-shelf availability; quick delivery of spare parts; and fast, reliable service. For more information contact Aydin Controls, 414 Commerce Drive, Fort Washington, PA 19034. Tel: 215-542-7800 (TWX 510-661-0518).

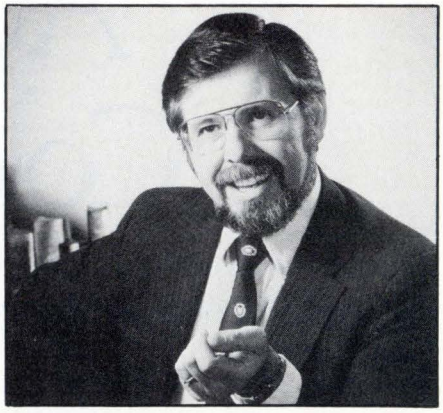


AYDIN CONTROLS

CIRCLE NO. 53 ON INQUIRY CARD

The iAPX 186-based system will run Digital Research, Inc.'s concurrent CP/M-86 and its multi-user, multi-tasking MP/M-86.

A single-cabinet Victory system includes the processor board with the MC68000 or iAPX 186, 256K bytes of RAM, memory management, eight serial (RS422) ports and 24 parallel ports and a Z80B to handle I/O. A second board controls all mass-storage peripherals. These include either a 40M-byte, 8-in. Winchester disk drive from Quantum Corp. and a 1M-byte, 8-in. slimline floppy disk drive or a Seagate Technology Corp. 5¼-in., 6M-byte Winchester and a 1M-byte, 5¼-in. floppy.



Roger Vass is founder of Victory Computers, Inc., *which is releasing its first product, a multiple-microprocessor-based system that handles eight to 16 users on a VME bus backplane.*

Vass plans to incorporate Seagate's removable Winchester cartridge drive for backup. The drive controller, which uses a Z8000, can handle as many as four of each device. A 1M-byte RAM board is optional. All boards are double-width Eurocards. The chassis includes a six-slot backplane, and can accommodate any VME-compatible card, Vass says.

The system also includes a slave processor using a Z80. Vass says this slave board will run 8-bit CP/M and will expand the system's serial I/O as users are added. As a CP/M processor, the board allows access to the software written for that operating system.

Vass hopes to build a family of four or five systems based on the chassis and cabinet used for the initial product.

The company will use distributors in the U.S. and Europe, where Vass expects to do about 50 percent of his business. He also says he would consider selling the system boards separately through another company. —*Larry Lettieri*

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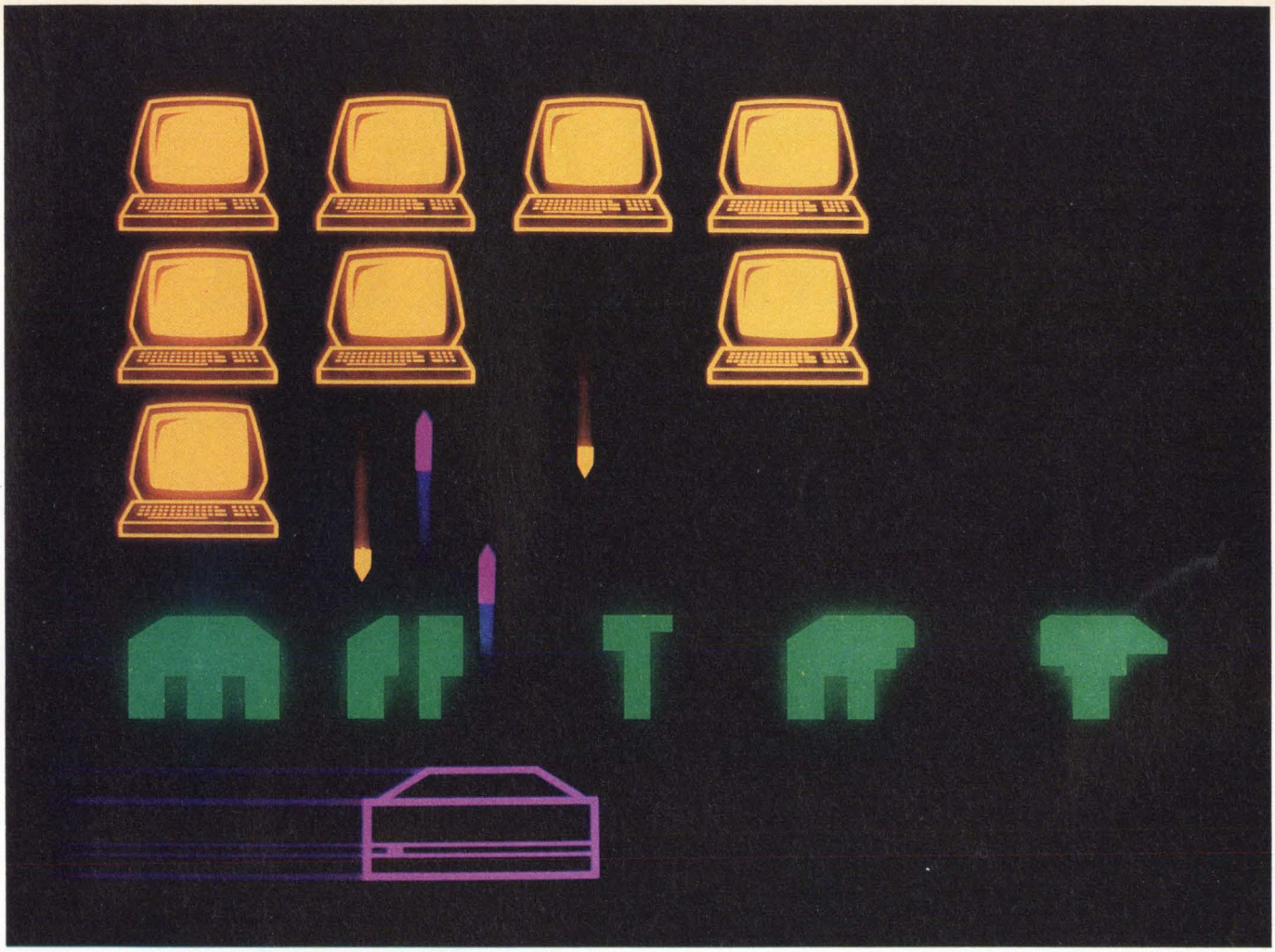
CIRCLE NO. 54 ON INQUIRY CARD



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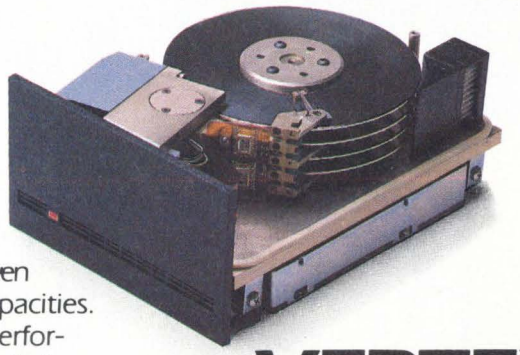

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CIRCLE NO. 55 ON INQUIRY CARD

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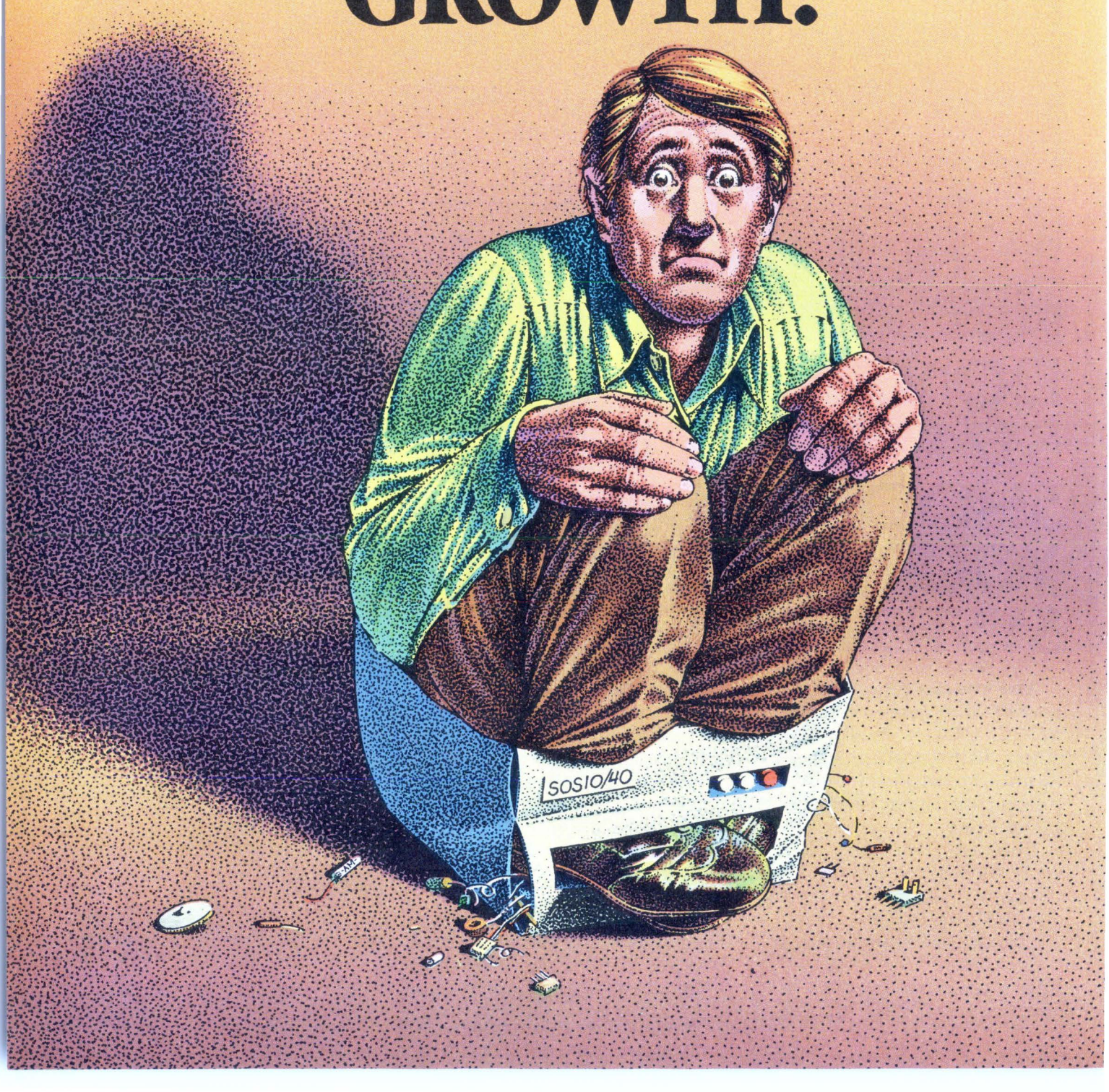

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* Ethernet is a trademark of Xerox Corp. UNIX is a trademark of Bell Labs. XENIX is a trademark of Microsoft.

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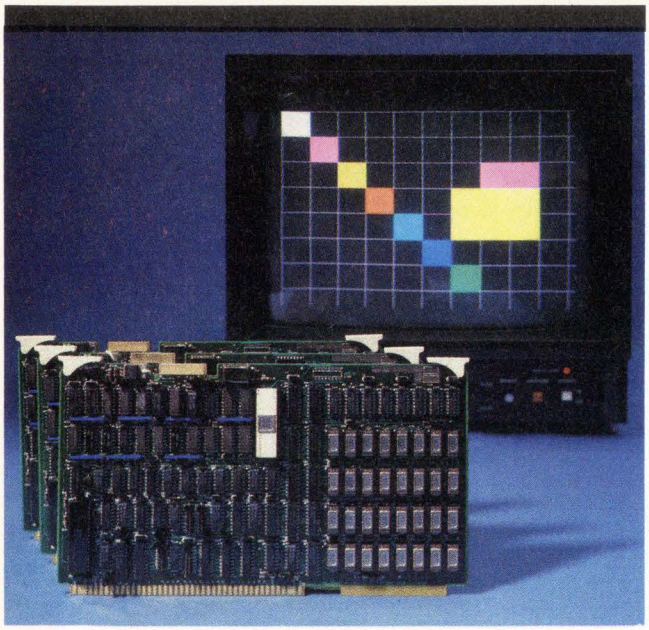

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Mini-Micro World

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NOVEMBER

16-18 **1982 International Test Conference—Cherry Hill '82,** Philadelphia, sponsored by the IEEE Computer Society and the Philadelphia section of the IEEE. Contact: Doris Thomas, Conference Registrar, P.O. Box 371, Cedar Knolls, N.J. 07927, (201) 267-7120.

16-19 **"Logical Data Modeling" Seminar,** Ann Arbor, Mich., sponsored by The DMW Group, Inc. Contact: William Maurer, The DMW Group, Inc., Publishing & Seminar Division, 2020 Hogback Rd., Ann Arbor, Mich. 48104, (313) 971-5234.

17 **"Network Optimization and Tariff Impact Strategies" Seminar,** New York, sponsored by The DMW Group, Inc. Contact: William Maurer, The DMW Group, Inc., Publishing & Seminar Division, 2020 Hogback Rd., Ann Arbor, Mich. 48104, (313) 971-5234.

18-21 **Applefest San Francisco,** San Francisco, sponsored by The National Computer Shows and Office Equipment Expositions. Contact: Northeast Expositions, 822 Boylston St., Chestnut Hill, Mass. 02167, (617) 739-2000.

29-30 **"IBM Telecommunications, Office Systems and DDP Directions" Seminar,** London, England, sponsored by The DMW Group, Inc. Contact: William Maurer, The DMW Group, Inc., Publishing & Seminar Division, 2020 Hogback Rd., Ann Arbor, Mich. 48104, (313) 971-5234.

NOV. 29-DEC. 2

COMDEX '82, Las Vegas, sponsored by The Interface Group. Contact: The Interface Group, 160 Speen St., P.O. Box 927, Framingham, Mass. 01701, (800) 225-4620 or (617) 879-4502.

NOV. 29-DEC. 2

1982 GLOBECOM Telecommunications Conference, Miami, sponsored by the Communications Society of the IEEE. Contact: Liang Li, Publicity Chairman, Gould S.E.L., 6901 W. Sunrise Blvd., P.O. Box 9148, Fort Lauderdale, Fla. 33310-9148, (305) 587-2900, ext. 5740.

NOV. 30-DEC. 1

"Understanding and Using CAD/CAM" Seminar, New York, sponsored by Frost & Sullivan, Inc. Contact: Carol Sapchin, Account Representative, Frost & Sullivan, 106 Fulton St., New York, N.Y. 10038, (212) 233-1080.

NOV. 30-DEC. 2

1982 Canadian Symposium of the International Information/Word Processing Association, Montreal, Canada, sponsored by the IWP. Contact: Susan Cooke, IWP, 15 Toronto St., Suite 702, Toronto, Ontario, MFC 2E3, (416) 365-7609.

NOV. 30-DEC. 2

MIDCON/'82 High-Technology Electronics Exhibition and Convention, Dallas, sponsored by Electron-

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CIRCLE NO. 58 ON INQUIRY CARD

Mini-Micro World

CALENDAR

ic Conventions, Inc. Contact: Eileen Algaze, Communications Coordinator, 999 N. Sepulveda Blvd., El Segundo, Calif. 90245, (213) 772-2965 or (800) 421-6816.

NOV. 30-DEC. 3

Semiconductor International/U.K., Brighton, England, sponsored by the ISMC. Contact: Ed Troogstad, ISMC, 222 W. Adams St., Chicago, Ill. 60606, (312) 263-4866.

NOV. 30-DEC. 3

North American Telephone Association 13th Annual Convention and Exhibition Showcase, Washington, D.C., sponsored by NATA. Contact: NATA, 511 Second St., N.E., Washington, D.C. 20002, (202) 547-4450.

DECEMBER

2-3 **"Understanding and Using Computer Business Graphics" Seminar,** New York, sponsored by Frost & Sullivan, Inc. Contact: Carol Sapchin, Account Representative, Frost & Sullivan, 106 Fulton St., New York, N.Y. 10038, (212) 233-1080.

2-4 **SEMICON/Japan,** Tokyo, Japan, sponsored by SEMI. Contact: Shirley Pelmer, SEMI, 625 Ellis St., #212, Mountain View, Calif. 94043, (415) 964-5111.

7-9 **DEXPO/West '82 Second National DEC-Compatible Industry Exhibition,** Anaheim, Calif., sponsored by Expocounsul International, Inc. Contact: Expocounsul International, Inc., 19 Yeger Rd., Cranbury, N.J. 08512, (609) 799-1661.

8-10 **21st Conference on Decision & Control,** Orlando, Fla., sponsored by The Massachusetts Institute of Technology. Contact: Dr. A.H. Levis, 35-410/LIDS, MIT, Cambridge, Mass. 02139, (617) 253-7262.

9-12 **Southeast Computer Show & Office Equipment Exposition,** Atlanta, sponsored by Computer Expositions, Inc. Contact: Computer Expositions, Inc., P.O. Box 3315, Annapolis, Md. 21403, (301) 263-8044 or (800) 368-2066.

13-15 **International Electronic Devices Meeting,** San Francisco, presented by Courtesy Associates. Contact: Melissa Widerkehr, Courtesy Associates, 1629 K St., N.W., Washington, D.C., (202) 296-8100.

13-15 **National Conference on Small Computers in Government,** Washington, D.C., sponsored by George Mason University, Public Management Institute. Contact: Zelda Rottenberg, U.S. Professional Development Institute, 12611 Davan Drive, Silver Spring, Md. 20904, (301) 622-5696.

13-16 **Second Gulf Computer Exhibition,** Dubai, United Arab Emirate, organized by Trade Centre Management Co. Contact: MABCO, Inc., 739 Boylston St., #308, Boston, Mass. 02116, (617) 536-3440 or 7435 Tillman Dr., Falls Church, Va. 22043, (703) 734-1962.

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CIRCLE NO. 59 ON INQUIRY CARD

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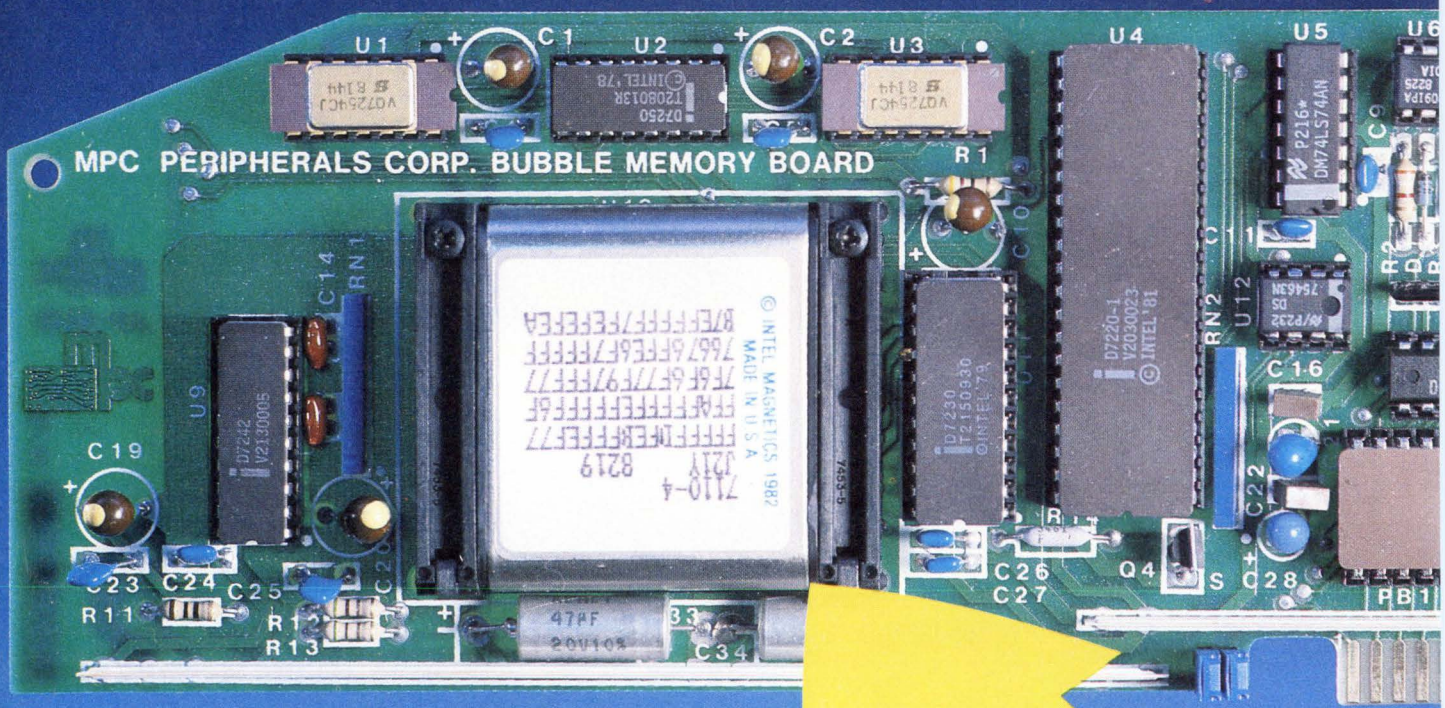

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CIRCLE NO. 60 ON INQUIRY CARD

Modcomp may buy ATM Computer if AEG Telefunken folds

Modular Computer Systems, Inc., Fort Lauderdale, Fla., most likely will take over its West German associate ATM Computer if ATM's majority shareholder, ailing electrical and electronics giant AEG Telefunken AG goes bankrupt.

After years of financial difficulties, AEG Telefunken went into the West German equivalent of Chapter XI in July, offering to pay its creditors 40 percent of debts owed as an alternative to nothing if it is forced into bankruptcy.

ATM, established in early 1980, is 75 percent owned by AEG Telefunken, and 25 percent owned by Modcomp. The company's plans then were to pool the two firms' resources in the West German industrial-control market. One attraction for Modcomp was the $30 million that AEG Telefunken paid for its controlling share in ATM and for a 25-percent share in Modcomp. At the time, Modcomp appeared to be in worse financial condition than AEG, with slow growth in revenues and declining profits.

Under the agreement, ATM embraced the West German sales force

Illustration by Jon McIntosh

The crumbling pieces of AEG Telefunken *are being eyed by some U.S. manufacturers wishing to incorporate them into their own businesses.*

UTC, TELEFUNKEN CREATE JOINT VENTURE COMPANY

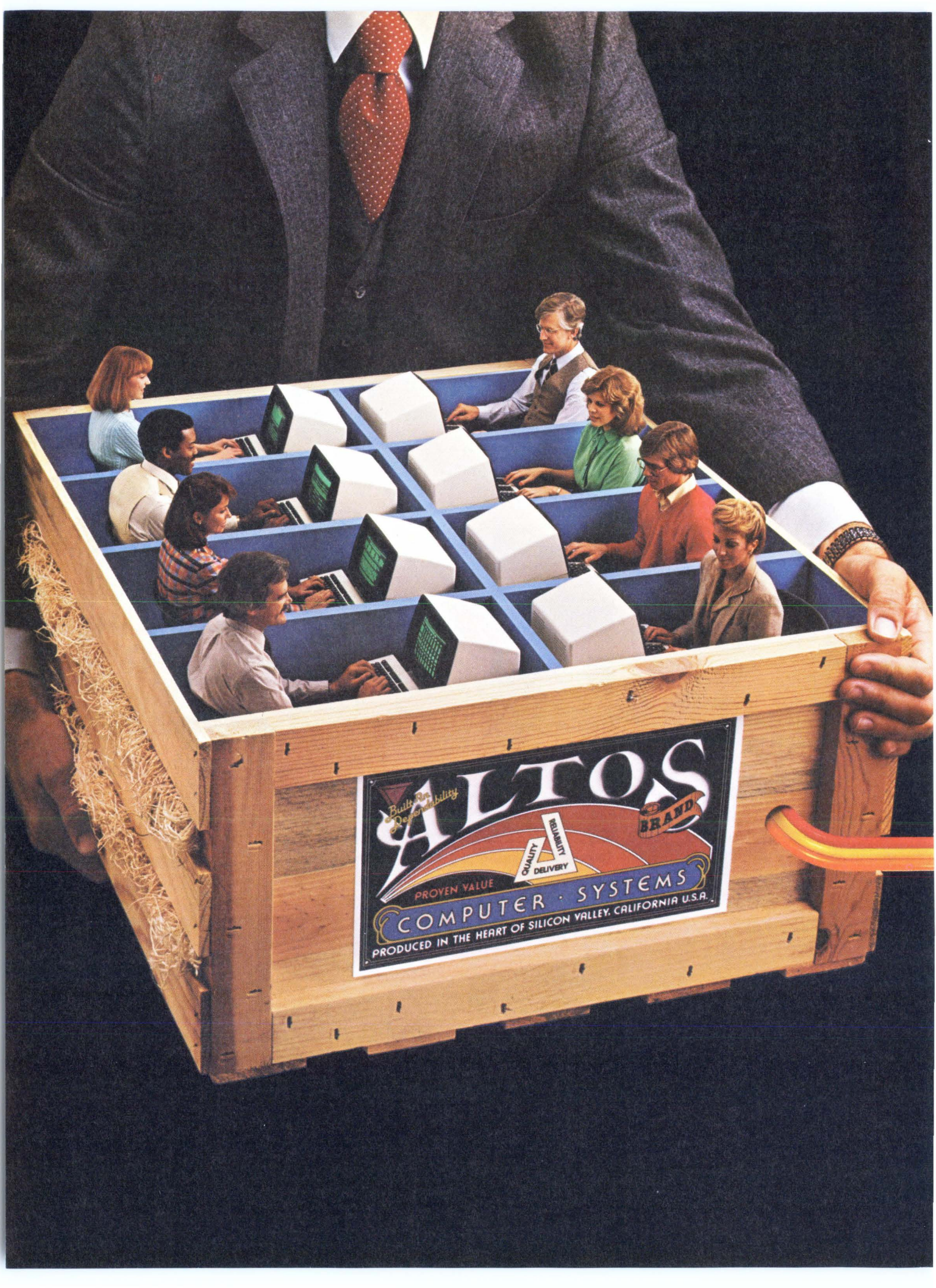
United Technologies Corp. and AEG-Telefunken AG have signed an agreement to create an electronic-components joint venture company, Telefunken Elektronische Bauelemente GmbH (TBG), which was scheduled to begin operations early this month. The partners will each hold 49 percent, and Gueddeutsche Industriebeteiligungs GmbH, a subsidiary of Dresdner Bank AG, will hold the remaining 2 percent.

TBG will continue the activity of AEG's Elektronische Bauelemente Division and will take over its assets, as well as the manufacturing of discrete semiconductors, opto-electronic components, ICs, solar cells and thick-film circuits. Technical tube activities will remain with AEG-Telefunken.

TGB is expected to achieve a first-year sales volume of approximately $170 million. It will have a work force of 3300 in Germany and 2200 in Austria and the Philippines.

The joint venture agreement calls for TBG and UTC to form a new company, Telemos Electronic GmbH, which will develop and produce custom semiconductor devices using NMOS, CMOS and gate-array technology.

Under the agreement, UTC's Microelectronics Center, Colorado Springs, Colo., and UTC's Mostek subsidiary, Carrollton, Texas, will cooperate to introduce advanced VLSI technology to Telemos. A 1980 agreement exists between AEG-Telefunken and Mostek for microprocessor products.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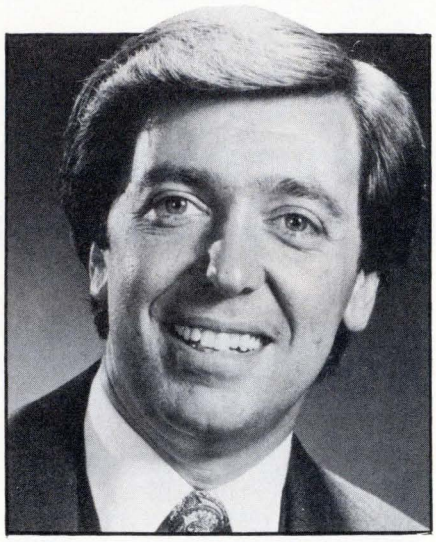
CIRCLE NO. 61 ON INQUIRY CARD

of Modcomp, which continued to sell Modcomp's Classic minicomputers. The new company also took over AEG's own process-control product line and sales force, which sold almost exclusively to other companies within the AEG empire. AEG computers were to be replaced by the new generation of Modcomp 32-bit machines, which were expected to emerge early in 1982 and supersede the Classic family.

These plans are proceeding, although behind schedule, says Modcomp president Gabriel Rosica. He explains that the original 32-bit project was aborted because the development group was not producing a machine that Modcomp needed. Hence, Modcomp made an agreement early this year with Control Data Corp., under which Modcomp bought a 32-bit design for military fail-safe applications. "We purchased the machine outright from CDC in return for 90,000 Modcomp shares," Rosica explains.



Modcomp president Gabriel Rosica *is in a position to buy AEG Telefunken's ATM Computer should the electronics giant go bankrupt.*

"There are no subsequent license payments on the hardware. The machine fundamentally is an emulator, so we will be able to emulate the Classic on it and the AEG machines. It will be ready by the end of 1983."

Rosica doubts that AEG Telefunken will go bankrupt. But if it does, says Rosica, "Modcomp will offer money for the 75-percent AEG Telefunken share. We can demand those shares in return for a fair settlement."

But Rosica notes that Europe is not as big a market for Modcomp as it once was, declining from as much as 30 percent of the company's turnover when ATM was founded to 15 percent now. "ATM did not grow as much as we had hoped," Rosica admits. "But our sales all over Europe have grown slowly, not just in Germany." Rosica blames the general economic recession in Europe for the poor performance.

If AEG Telefunken does go bankrupt, parts of the company that will operate under new ownership will need support for any AEG computers they have installed. Rosica says Modcomp may take on the servicing task if it takes over ATM. —*Keith Jones*

CCT meshes resources to become broad-based disk supplier

Vertical integration is the key to becoming a broad-based supplier of rigid-disk drives to OEMs because it lowers component costs and, thus, drive costs, says Everett Bahre, chairman and chief executive officer of Goleta, Calif.-based Communications and Computer Technology, Inc. That is the competitive edge that Bahre will use in mobilizing his resources to focus on drives.

"With the cash resources we have, now is the time to move. We may never have the opportunity again," he says. To finance CCT's move into the disk-drive business, Bahre has been using $35 million obtained from a stock offering last spring. At the end of CCT's fiscal year last December, the company posted $66.2 million in revenues for all divisions, and, this summer, it announced six-month 1982 revenues of $41 million.

Bahre already is putting some key strategies in place. He plans to combine CCT-owned Data Peripherals, a Sunnyvale, Calif., supplier of 8-in. removable Winchester drives, and Rotating Memory Systems, a Milpitas, Calif., vendor of high-capacity, 5¼-in. Winchester drives, into a subsidiary named Disctron Inc. The new company will be able to capitalize on CCT's position as a large-scale manufacturer of Winchester drive heads through its Infomag subsidiary. Another gem for CCT is a license with Ampex Corp. for thin-film media, which CCT has incorporated into forthcoming drives. RMS is a recent purchase by CCT for $9.8 million in cash and stock.

According to Bahre, 75 to 80 percent of the total costs incurred by an OEM Winchester vendor are material costs, with heads and media accounting for the lion's share. This product cost will separate OEM drive vendors, he says, and could impact the survivability of some. "In a drive that costs the vendor $500 to build, $200 could go toward these two items," he says. "This means that at the same selling price, the drive vendor that makes heads and media will be more profitable." It also means that in the

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price-sensitive small-Winchester business, the vertically integrated drive maker may have a $30 to $40 cost advantage over his competition, he says.

CCT plans to move aggressively into thin-film media using the license agreement signed this year with Ampex. Thin-film media capability will be a prerequisite for disk-cartridge drives such as the 10M-byte DP-100 removable-only "Lynx" developed by Data Peripherals, and for a 5¼-in. version that could show up at the Comdex show in Las Vegas, Bahre says.

Thin-film media will also be used on future 5¼-in. Winchester iterations based on RMS designs, he says. One such design, a half-high, three-platter, 45M-byte 5¼-in. device with manganese-zinc ferrite heads, could be unveiled at Comdex. "The industry has discovered thin-film media," he says, "and it could be a tremendous growth business for us." CCT is setting up a facility to make these platters in the San Francisco Bay area, and Bahre anticipates volume production by next June. CCT's drive operations will be headquartered in the RMS facility in Milpitas. Future drives could include 8-in. Winchesters with 120M- to 140M-byte capacities.

The decision to move aggressively ahead with media in addition to its read/write head business could put CCT in the position of competing with its own customer base. So far, however, Winchester vendors that rely on InfoMag for heads do not seem overly concerned.

InfoMag, while a leading manufacturer of Winchester heads, is not the only vendor of these parts, and drive vendors are not facing a pinched supply. Thin-film media now is more the latest industry buzzword than a product in short supply.

"Competing with our customers is of concern to us, and, no doubt, there will be some impact," Bahre admits. "But we cannot grow if we remain predominantly a head supplier."

While Bahre feels that his company's push into the disk-drive business and its thin-film media debut may be a case of perfect timing, that was not the case in the establishment of Data Peripherals. Bahre admits that the company has not had a major impact on the market. One Bay Area observer agrees: "The initial strategy of Data Peripherals was to build a drive that would replace the 2314-technology RL-01 and RL-02 5M- and 10M-byte, 14-in. disk-cartridge drives marketed by Digital Equipment Corp., and then sit back and wait for DEC to announce its version and define the market," says Andrew Roman, Newark, Calif., industry analyst and publisher of *The OEM Disk Products Pricing Report*. "But so far, DEC has not announced this product, although it could show up this fall at Comdex."

Bahre explains that rather than miss a market window, Data Peripherals introduced a product early and then stumbled over the interface issue that bedeviled the 8-in. Winchester market almost from its very beginning. When the Lynx was introduced, the low-end, 8-in. Winchester business was rapidly moving toward an interface standard set by Shugart Associates' SA1000. Because the Lynx used removable media, it was not fully compatible with this interface. That hurt and still does, Bahre says.

CCT also faces a challenge at RMS, given the hardball pricing in the 5¼-in. Winchester market since the beginning of the year (MMS, April, p. 97). It is here that Bahre's focus on key component costs and vertical integration may get the most severe test.

"A lot of system designers are already committed to low-end suppliers," says Jim Moore, director of computer memory industry services at Dataquest, Cupertino, Calif. "But if they can make all the components play over at CCT, the company should be in a good position to move into the mid-range 5¼- and 8-in. Winchester markets."

—John Trifari

GSA studying microcomputer procurement

The General Services Administration Office of Information Resources Procurement is considering issuing a request for proposals in five or six months for microcomputers ranging in price from $100 I.C. $15,000. GSA now procures the computers when agency personnel want one or as part of the Multiple Award Schedule Contract.

GSA officials see the action as a pilot study aimed at combining GSA's and one other government agency's requirements for microcomputers into a single procurement. They do not know how much the final contracts will be worth, but their value should be considerable. They also believe that several companies will be awarded contracts. If the pilot program works, it could lead to government-wide procurement of the computers, the officials say.

A microcomputer award would permit the government to take advantage of economies of scale and bulk quantity purchasing. The project has won the initial approval of top agency officials, and final approval is a good possibility, say GSA officials.

MARKET BAROMETER

A new monthly column devoted to an expert's look at an industry

Line printers: out of the doldrums?

By O. Ralph Finley
Dataquest, Inc.

The stable market for minicomputer line printers has been in the doldrums for the past year. As shown in the accompanying charts, line-printer market share shrank from the dominant revenue producer with 70 percent of the market in 1976 to 44 percent in 1981, and Dataquest research indicates that it will drop to approximately 30 percent by 1986. The market size for line printers still is expanding, but simply is not growing as fast as other segments, as shown by unit shipments. The line-printer market will grow from 144,300 units in 1981 to an estimated total of 235,000 units in 1986. The figures represent revenue generated by purchase, maintenance and lease.

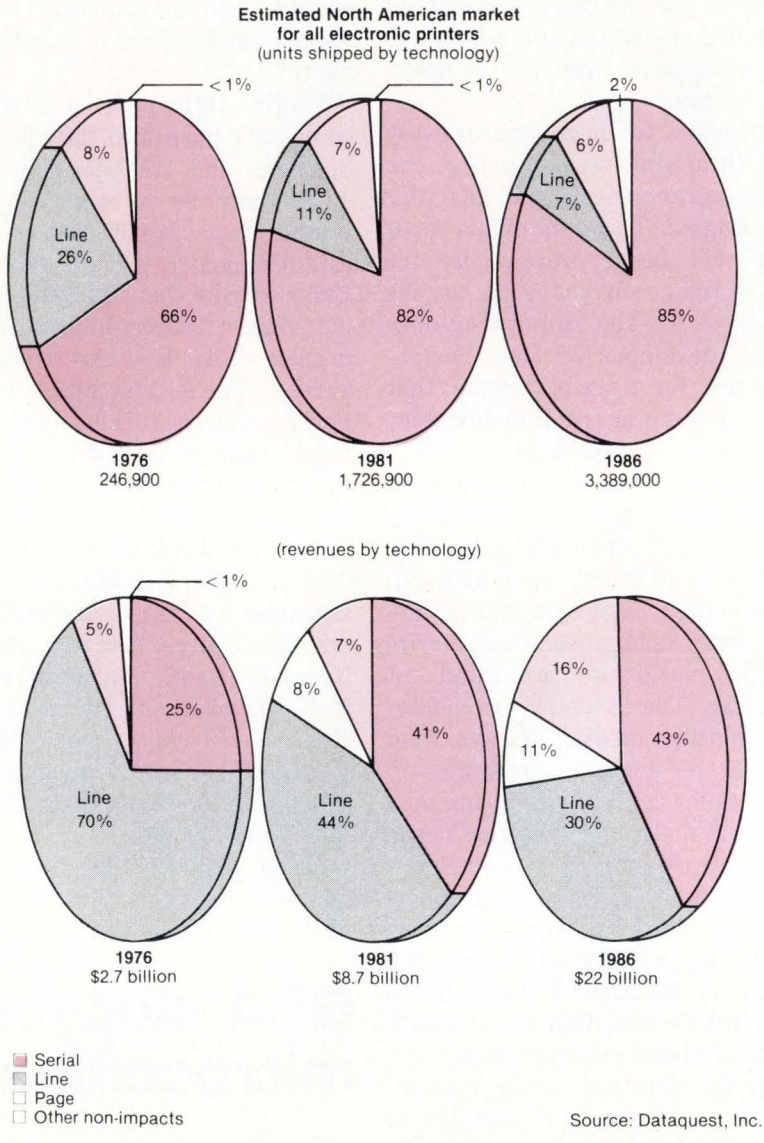
At the same time, there is a strong shift toward the OEM purchase of line printers instead of in-house manufacture by large minicomputer firms. Companies such as Dataproducts Corp., Data Printer Corp., Documation, Inc., Hitachi and Centronics Data Computer Corp.'s Line Printer division (formerly CPI) are shipping more units and realizing strong economies of scale in manufacturing. OEM suppliers have gone from a 29-percent market share in 1976 to 44 percent in 1981, and Dataquest estimates they will capture 57 percent of the overall line-printer market in 1986.

So why the doldrums?

Last year, line-printer manufacturers reported that business was off, and bottom lines had been battered. Dataquest research indicates the primary reason for weak performance has been economic rather than endemic. A characteristic of the OEM business is the "pipeline effect." During growth, the flow of products from OEM line-printer manufacturers is six months to more than a year long. In an economic downturn, if orders fall off at the computer-system level, system manufacturers typically delay or cancel OEM orders to reduce inventory.

If the current recession ends and the economy rebounds, OEM line-printer manufacturers will see a dramatic increase in orders to fill the pipelines. A company such as Dataproducts, which has consciously maintained production capacity in the face of soft delivery orders, could be amply rewarded for its perseverance.

The most important long-term growth factor is the ultimate effect of non-impact printers. Those priced at $100,000 or less are still in their infancy, and will begin to affect seriously a broad range of printer applications beginning in 1984.



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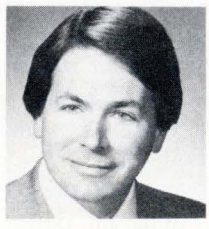

O. Ralph Finley, vice president of Dataquest, Inc.'s Peripherals Group, Cupertino, Calif., is director of the Electronic Printer Industry Service.

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Your computer's memory capacity has just about doubled with Microscience's innovative half-height disk drive – the Model HH-612. Using half the space of conventional 5¼" Winchester drives, the HH-612 allows you to mount two drives with up to 25 Mb into the same area that held a 6.4 Mb unit.

Equally important are the HH-612's advanced features shown above. While only 1.625" high, this compact drive, using a rugged, thin-film media, can provide 10 Mb of formatted ST506-compatible storage, or alternate unformatted packing densities of 12 Mb and, with 2/7 coding, 18 Mb.

On the mechanical side, the HH-612 is shock mounted to reduce vibration; on the electronics side, dual microprocessors make it unique in the disk drive field. Superb tracking comes from a closed loop positioning system, and rapid access time is achieved with a highly-innovative non-linear buffer seek program.

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If you need more detailed information about how the HH-612 can fit into your computer, write or call our President, Jeffrey Liu. *Evaluation units are available to qualified OEM's.*

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Most of the HH-612 special features, not found in other drives, are included in the base price.

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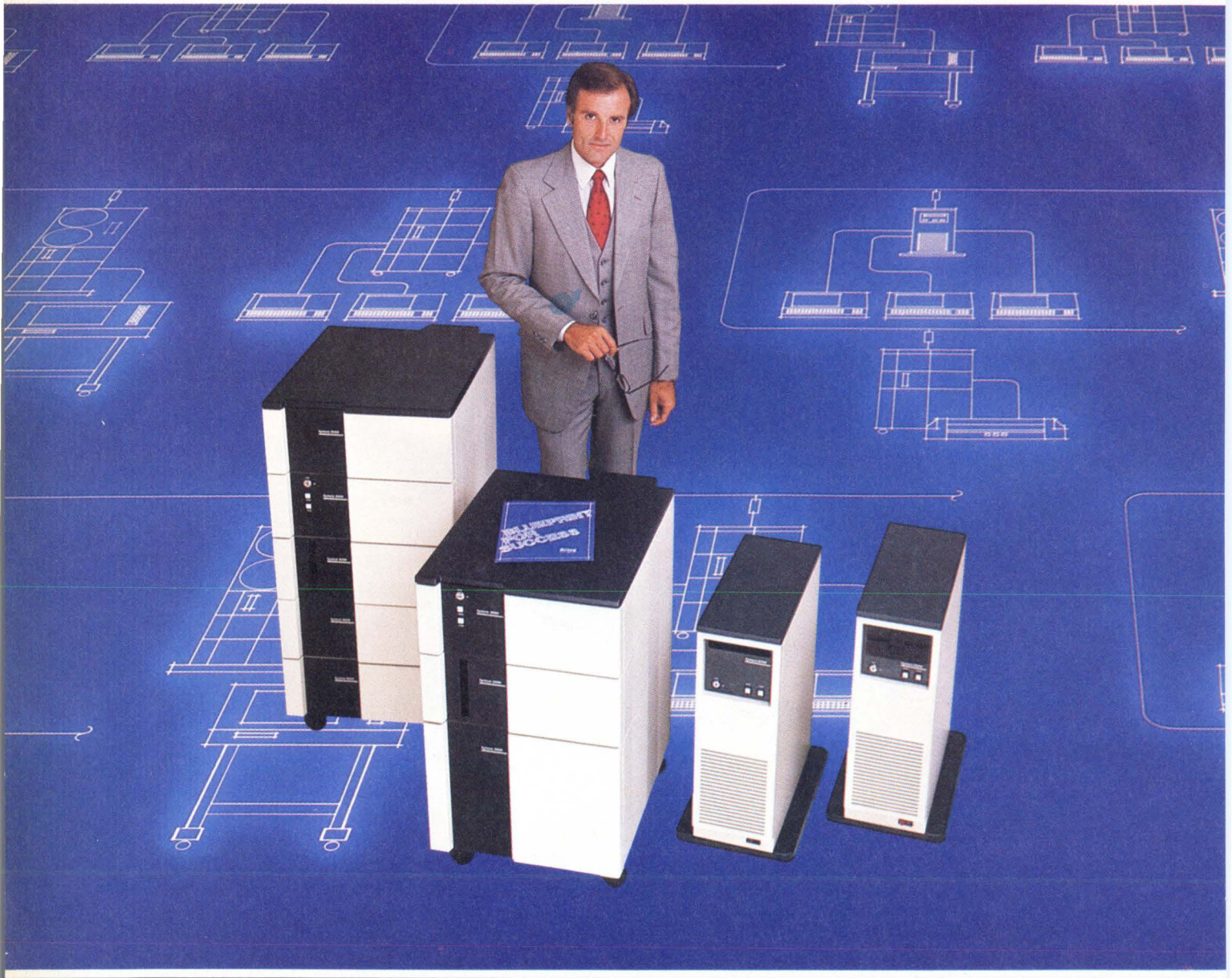
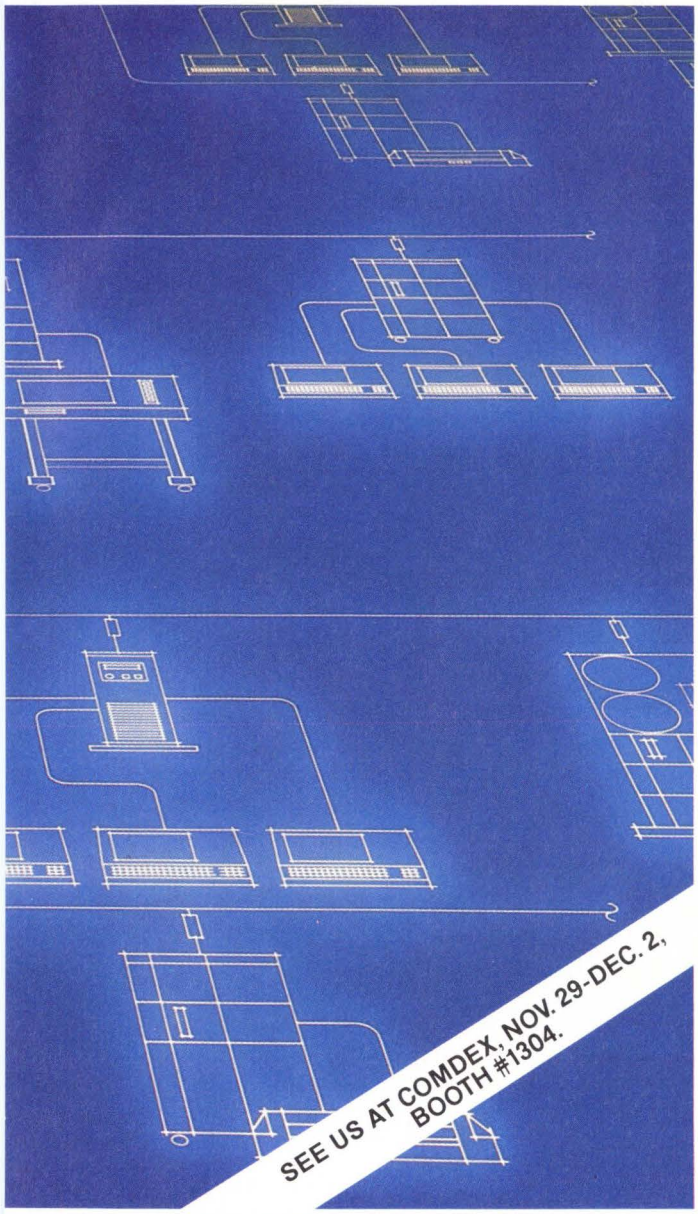
Zilog's System



8000 family spells OEM success.



Zilog's System 8000 is a growing family of totally compatible general purpose 16-bit microcomputers designed for high performance and reliability. Priced from $13,000 to under $40,000, they are rapidly becoming the choice of successful OEM's for a growing variety of applications.

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For higher performance, choose the Model 21. It features 1 MB of ECC memory, a 32 MB Winchester disk and a 17 MB cartridge tape for backup.

For the highest performance of all, select the Model 31, the remarkable micro comparable in performance to minis, yet priced far less. It delivers up to 4 MB of ECC memory, plus up to 320 MB of SMD compatible disk and offers an optional 9 track tape. Model 31 also supports up to 24 users simultaneously.

Best of all, the System 8000 family has been designed to take full advantage of the powerful UNIX* operating system. System III has been added to further enhance application software development, making System 8000 computers your best choice to run high level languages such as BASIC, COBOL, FORTRAN 77, C, Pascal, PLZ/SYS and Z8000 assembler. All software is code and data compatible, allowing for total portability among all family systems. Inside all System 8000s are the high performance VLSI components you've come to expect from Zilog. The Z8000™ is a 16-bit CPU with 16 general purpose registers, an 8 MB address space and expanded capability to perform 8-bit, 16-bit and 32-bit operations. In addition, each system can communicate via the Z-NET II local area network, and with other UNIX-based systems as well.

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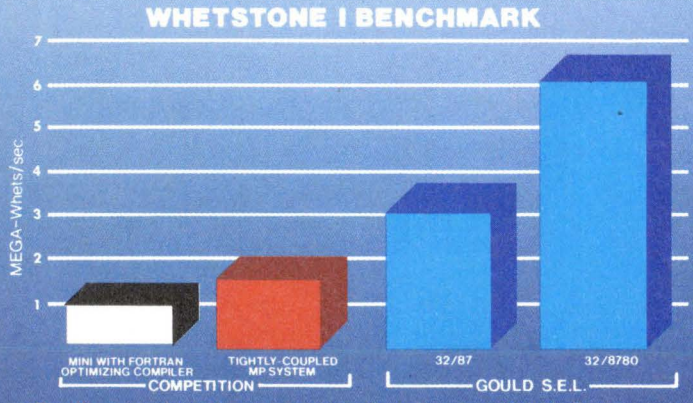

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GUEST FORUM

A new monthly column for guest experts to speak out

How to save taxes on computer software

By David Oifer
Coopers & Lybrand

If General Electronics Co. spent $50,000 on computer software research in the fiscal year ended June 30, 1981, and $100,000 for the same purpose in the following year, it could claim $12,500 for fiscal 1982 as a research tax credit and also deduct all its costs—if it follows the rules.

This healthy tax break is the result of research efforts receiving strong encouragement in the Economic Recovery Tax Act of 1981. There are several other positive approaches to tax management on software, ranging from straight expensing of costs in the current year to amortizing software and obtaining an investment tax credit at the same time.

The ERTA provisions add section 44 F to the Internal Revenue Code to allow 25 percent of the amount spent in a base period average to be taken as a credit against taxes.

In the case of General Electronics, which spent $50,000 on R&D in the year ended June 30, 1981, it can credit 25 percent of the additional $50,000 increment spent in the year ended June 30, 1982—a tidy $12,500.

The credit applies only to expenditures made after June 30, 1981. The base period can consist of as many as three years, but transitional rules are applicable for the first two years ending after June 30, 1981.

All software in the R&D program must be used in carrying on a trade or business and cannot involve standard programs. Custom software developed in-house qualifies nicely for the tax credit. But whenever research software costs are deducted, a tax payer must be able to show that the software is useful.

The software is considered to be intangible personal property in connection with the research tax credit; acquisition costs of depreciable property cannot be used in figuring the research tax credit. For example, if someone buys a new computer on which to develop software, he could not count it as a research expenditure because the computer is tangible personal property subject to cost recovery (depreciation).

The many ERTA provisions are experimental. The government intends to encourage more research, but the tax credit provisions expire on December 31, 1985. Congress apparently wants to see how section 44 F works before making any long-term commitment. In my opinion, the chances are good that the research tax credit will be renewed, perhaps for a long time.

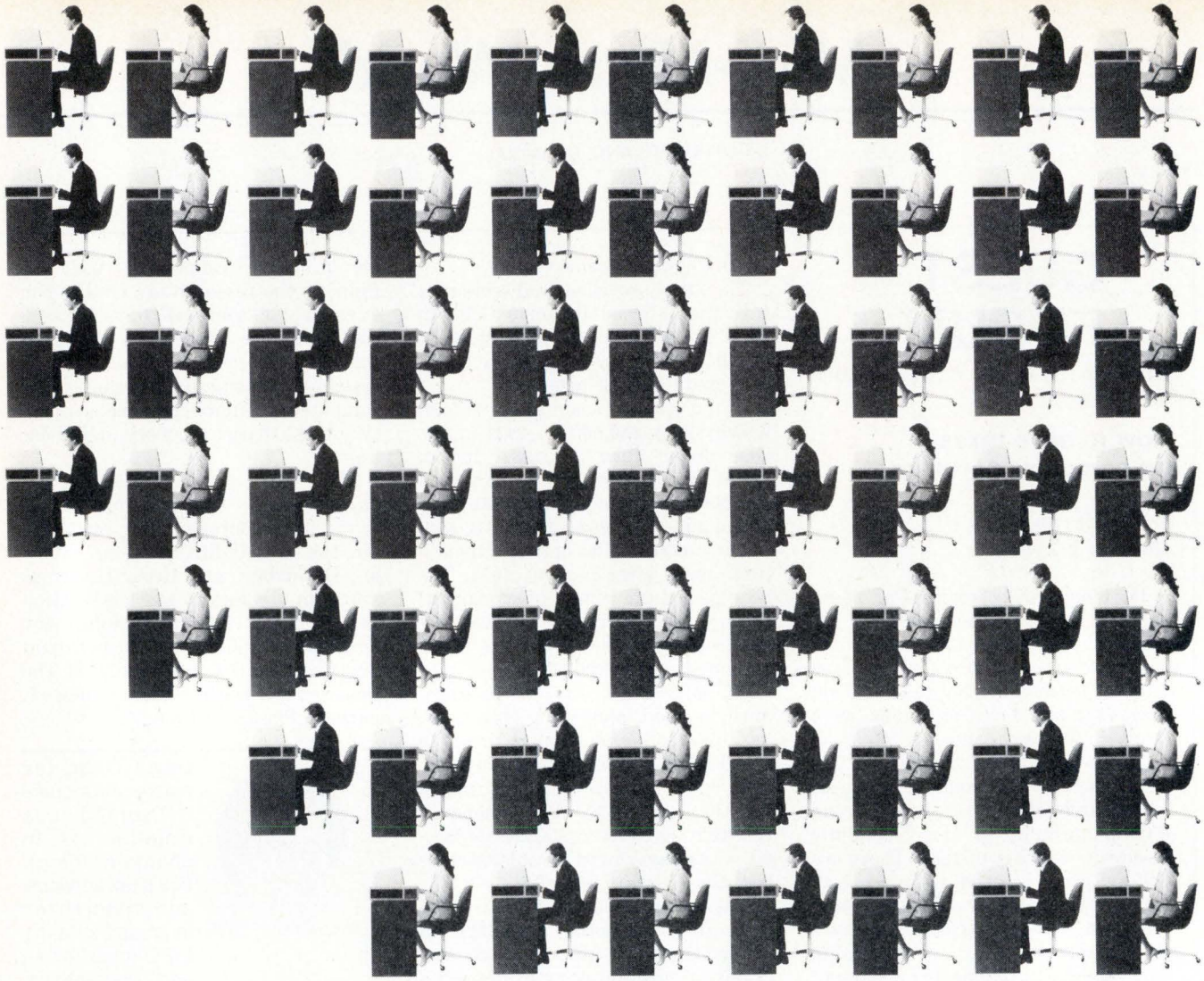
David Oifer, tax partner at Coopers & Lybrand, Los Angeles, is in charge of his office's tax services, and specializes in areas including LIFO inventories and cooperatives.

In Transition

Burroughs Corp. has folded its Danbury, Conn.-based Office Systems group, combining marketing functions for its office products with the B 20 microcomputer program. The combined organization, based at the company's Detroit headquarters, is headed by Ben L. Rouse, and will be known as the Business Information Systems group. Rouse, who now reports to Industry Systems group president William P. Conlin, had been responsible for the introduction of the Convergent Technologies-based B 20 and was reporting directly to chairman W. Michael Blumenthal. The move followed closely the departure of OSG president Roger Johnson, who assumed the presidency of Western Digital Corp., but it was not related to Johnson's leaving, Burroughs sources say. The new group was formed to provide broader "systems solutions" to business customers with B 20 microcomputers, Ofiswriter word processors, shared filing systems and facsimile equipment. Burroughs officials confirm that a word processor based on the Convergent hardware is forthcoming, although they emphasize that the Ofiswriter 400 system, manufactured at the former Redactron subsidiary in Yaphank, N.Y., has had a significant sales growth this year.

After two years in the U.S. and with only 400 systems installed, **R2E** is beefing up its operations here with a new management team and a new line of Intel 8086-based systems. R2E, the $80-million-a-year microcomputer subsidiary of French computer maker Cii-Honeywell Bull, is expecting its Roseville, Minn.-based R2E of America, Inc., to sell 100,000 units annually by 1985. President Pierre Asanchyev moved from the company's industrial division this year, and has assembled a new marketing and sales team including director of sales David A. Kreaker (formerly at CPT Corp.) and sales vice president Lee Stevens (previously with Astrocom and Data 100). Stevens says sales should amount to about $7 million this year and expects R2E products to appeal mainly to OEMs and vertical market systems houses.

The company's new Micral 9050, introduced simultaneously here and in France, is based on a 5-MHz Intel 8086 and features an 8089 DMA controller. It is offered with CP/M-86 and can be equipped with an 8087 math processor. Prices range from $5495 for a two-floppy drive version



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2. AM-1000W (winchester, choice of floppy or VCR backup)	10MB	40MB	128KB	256KB	3	3	A	B	AMOS*
3. AM-1042 (winchester)	32MB	2.4GB	512KB	3MB	2	26	A	B	AMOS*
4. AM-1062 (winchester)	60MB	2.4GB	512KB	8MB	2	68	A	B	AMOS*

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to $7495 for a system with a 5M-byte Winchester disk drive. The company also plans to add UNIX. Stevens says the company plans to bracket the 9050 with high- and low-end versions and will also incorporate DMA Systems Corp. fixed/removable Winchester disks on the 90 series.

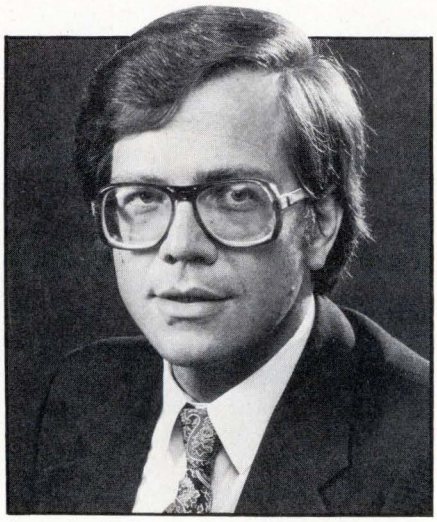
The company says it will concentrate on implementing local-networking capabilities, most likely Omninet from Corvus. Another effort that may put the company closer to its sales goals is an IBM Personal Computer-compatible system to be introduced by year-end.

A family of French-designed 32-bit minicomputers offering compatibility with the Honeywell Level 6 line is expected to be unveiled in 1985. This development will be the main result of a decision by the government to make sister companies of the largest European-owned minicomputer builder, **SEMS,** and **Cii-Honeywell-Bull,** which sells Level 6 machines in France.

The new 32-bit family will offer compatibility with the two 16-bit minicomputer lines built by SEMS—the Solar series, which is aimed mainly at process-control applications, and the Mitra family, which is directed primarily at networking and transaction-processing jobs.

SEM's ownership is being transferred from one government-owned electronics company, Thompson-CSF, to another, Compagnie des Machines Bull, the holding company of Cii-Honeywell Bull.

Shugart Associates has decentralized most of its operations and formed five major divisions. The divisions and their respective vice president/general managers are: Rigid Disk Drive, Tom Gardner; Floppy Disk Drive, Carl Neun; Sunnyvale, Paul Penney; Marketing and Sales, George Sollman; and Optimem, Peter Lloyd. Shugart also formed a central corporate staff with four groups: quality, finance and planning, personnel and administration and technology. As a result of the streamlined organization, the company has reduced its 3500-member work force by approximately 125 indirect (salaried) employees.



George Sollman *is vice president and general manager for Shugart's marketing and sales division, one of five new divisions formed to streamline the company's operations.*

Tandy Corp. has announced an agreement in principle to acquire, through a cash purchase, the 50-percent ownership interest in Texas Peripherals held by Datapoint Corp. The amount of the transaction was not disclosed. The transaction is subject to approval of the boards of both companies. Texas Peripherals was formed in 1980 as a joint manufacturing venture owned equally by Tandy and Datapoint to develop and manufacture disk products, in Odessa, Texas.

Financings

The Ultimate Corp. has amassed $6.3 million in a limited R&D partnership through E.F. Hutton & Co., Inc., to finance two hardware developments for its Honeywell minicomputers running the Pick operating system. The first product, similar to the Vulcan under development at Pick Computer Works (MMS, September, p. 6), is a Pick accelerator that Ultimate president Ted Sabarese says will run applications five times faster than current hardware. The second is a communications board that will provide access to remote Ultimate computers, local networks and public and private networks.

Formations

Intel Corp. has established two organizations: an iAPX 432 Technical Center within the Oregon Graduate Center in Beaverton, Ore., and a centralized Software Distribution and Support Operation, Santa Clara, Calif. The Technical Center provides specialized training and high-level support to Intel customers designing products based on the iAPX 432 micromainframe processors. The iAPX 432 typically is used for information-management applications requiring much software development. The center will help customer design teams learn the iAPX 432 architecture, the Ada language and the iMAX operating system. SDSQ will provide system-level support and distribution for third-party software, and support for Intel's software, on a contractual basis. The new division is a successor to Intel's Software Distribution Operation.

Donald J. Massaro and David Liddle, two key players in Xerox Corp.'s aggressive move into the office-automation market, have teamed up in a new venture called **Metaphor Computer Systems,** which plans broadly to address the needs of "operational" office workers such as administrative, marketing and financial personnel. Massaro, who was at Shugart Associates when it was acquired by Xerox in 1977, rose to the presidency of the Xerox Office Products division and was transferred this year to the presidency of the new Office Systems division (MMS, September, p. 79). Liddle

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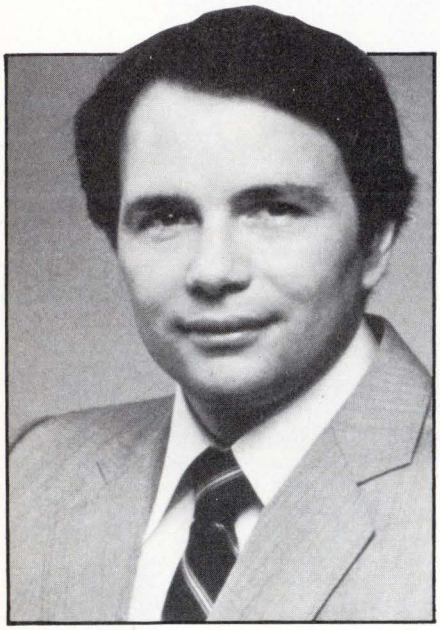

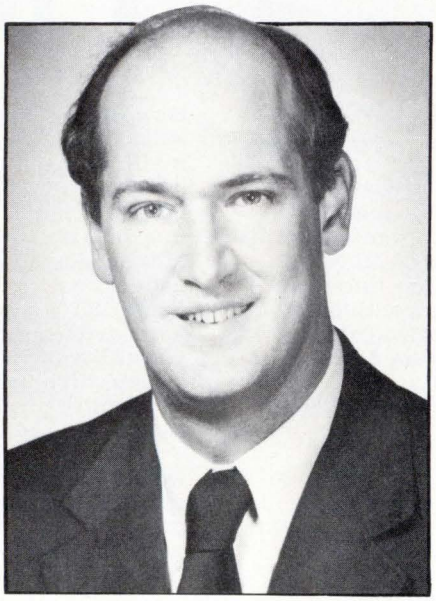

Former Xerox executives Don Massaro (left) and Dave Liddle *have struck out on their own with a new venture called Metaphor Computer Systems.*

was a vice president and general manager of the OPD unit responsible for Ethernet-related products. The two left in late September under "extremely amicable terms," Liddle says, after which William T. Bayer was named to a new senior vice president of operations post in the Information Products group, which oversees the OSD. Bayer temporarily retains presidency of Xerox Peripheral Systems (Shugart Associates, Century Data and Diablo Systems, Inc.). At the same time, OSD senior vice president Robert J. Ruebel was named senior vice president of Office Systems Marketing and Liddle's former assistant, John Shoch, was named president of OSD. Liddle and Massaro are working on a business plan and do not expect to introduce a product for two more years. They say Metaphor will work on various end-user products such as a workstation that will present information from mainframes or microcomputers in an accessible form for operational workers. Massaro and Liddle defined the Metaphor niche while at Xerox, but Xerox chose to bypass that niche in favor of other products.

Both Bunker Ramo and the Computer Factory *recently purchased Fortune's 32:16 microcomputer.*

Plessey Peripheral Systems is restructuring its domestic operations to focus on business in the North American market, while supporting its more profitable operating subsidiaries overseas. As a result, two autonomous units will be created. The Computer Products Division will oversee the market for memory boards, controllers and communications devices. The Systems Division will address vertical and end-user market segments with Digital Equipment Corp.-compatible systems.

Professional Data Corp., Cambridge, Mass., has introduced an interactive computer communications service for recruiting technical professionals. Called Connexions, the on-line service enables personnel, technical and general managers to list help-wanted ads demographically and geographically, receive applicants' résumés and pre-screen respondents with custom questions. Communication to the service is via terminals and personal computers. Recruiters pay to display an ad in the "electronic publication," which is much the same way traditional advertising works. Led by an easy-to-follow screen format, employers enter job listings from any terminal and telephone modem in their offices. Users also can control and restrict access to their résumé, assuring that only a prospective employer sees it.

Distribution, Service

Bunker Ramo Information Systems and the Computer Factory both have purchased **Fortune Systems Corp.'s** 32:16 microcomputer. The Computer Factory has agreed to purchase 500 units to sell in five metropolitan New York stores and two new stores. Bunker Ramo has signed a multi-year agreement valued at at least $15 million for the Fortune computer, which it will customize. Additionally, Fortune and Bunker Ramo announced a maintenance agreement under which Bunker Ramo will service all Fortune 32:16 systems through its nationwide organization.

Los Angeles-based peripheral manufacturer **C. Itoh & Co., Ltd.,** has agreed to supply Apple Computer, Inc., with an unspecified number of dot-matrix impact printers for use in Apple computer

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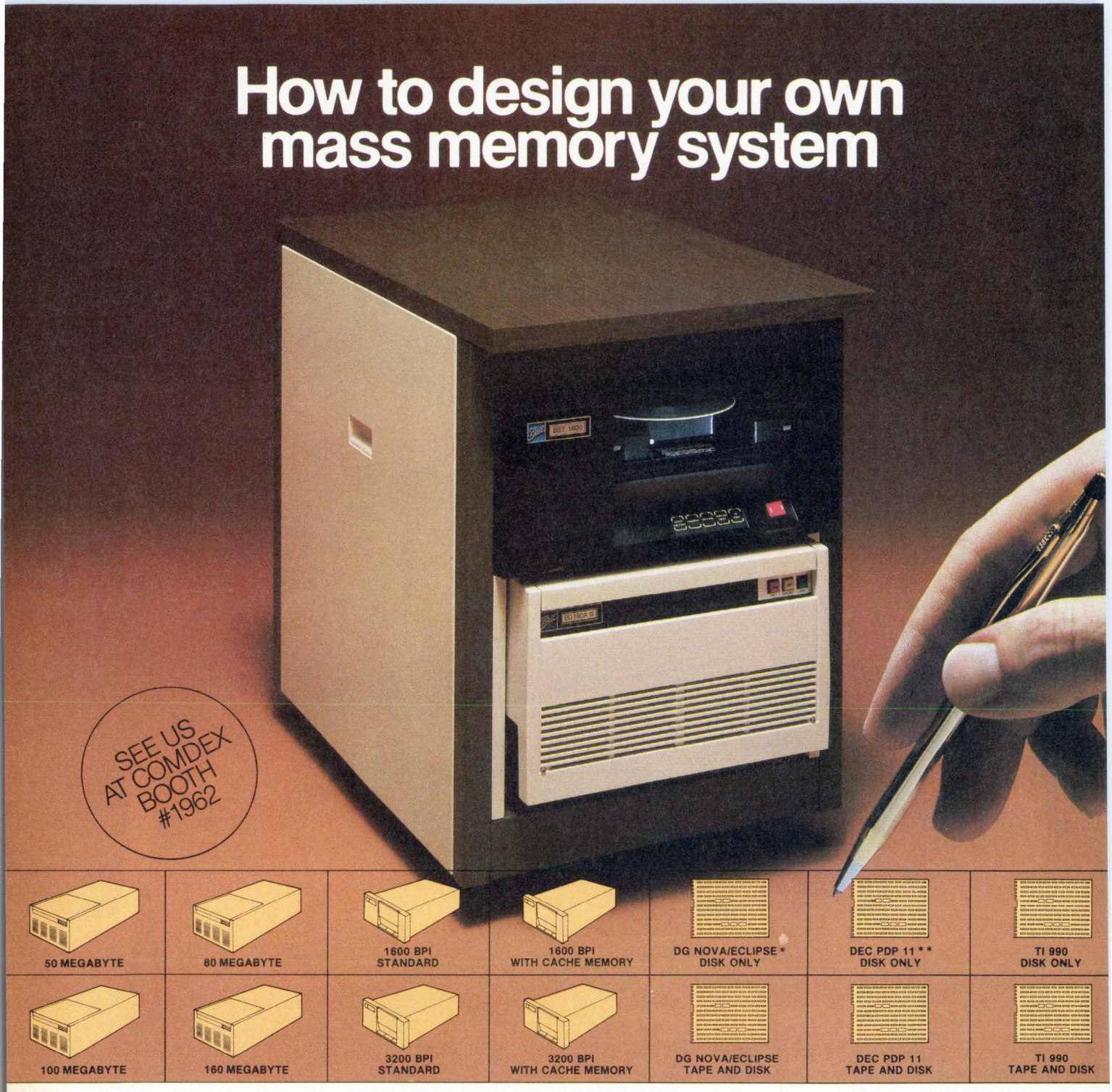
How to design your own mass memory system



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Mini-Micro World

CORPORATE AND FINANCIAL

BOX SCORE OF EARNINGS

This monthly table lists the revenues, net earnings and earnings per share in the periods indicated for companies in the computer and computer-related industries. Parentheses denote losses. Comments are from corporate summaries unless otherwise noted.

Company	Period		Revenues	Earnings	EpS
ASK Computer Systems, Inc.	year	6/30/82	22,769,000	2,338,000	.48
	year	6/30/81	13,000,000	1,491,000	.38
Computone Systems, Inc.	year	5/31/82	16,067,000	1,923,000	.98
	year	5/31/81	10,573,000	816,000	.48
Dataram Corp.	3 mos	7/31/82	3,650,000	(518,000)	(.22)
	3 mos	7/31/81	4,758,000	244,000	.10
Infotron Systems Corp.	6 mos	6/30/82	14,282,000	527,000	.13
	6 mos	6/30/81	10,569,000	892,000	.22
Mohawk Data Sciences Corp.	3 mos	7/31/82	87,389,000	3,555,000	.25
	3 mos	7/31/81	73,532,000	3,320,000	.25
Perkin-Elmer Corp.	year	7/31/82	1,036,774	62,669,000	1.45
	year	7/31/81	1,115,830	82,605,000	1.92
Prime Computer, Inc.	6 mos	7/4/82	208,296,000	21,533,000	.71
	6 mos	6/28/81	172,602,000	17,539,000	.58
Rolm Corp.	year	7/2/82	380,577,000	29,827,000	1.70
	year	7/3/81	294,576,000	23,777,000	1.39
Sanders Associates, Inc.	year	7/30/82	436,224,000	26,415,000	3.30
	year	7/31/81	364,483,000	21,873,000	2.75

Comments: ASK Computer Systems, Inc. increased its revenues 75 percent. The company's initial public offering last October provided $8.76 million, a significant contribution to its year-end equity base of $14.1 million. For **Dataram Corp.**, a general slowness in bookings in the first quarter severely depressed revenues. Even though the recession persists in the minicomputer industry, the company says its bookings rate is returning to normal, and revenues should increase in this quarter and return the company to profitability. In mid-September, the company reduced its core-memory-product work force by 15 percent. Core-memory revenues continue to decline as newer technologies replace that memory. During the quarter, the company also exercised its rights on $1.18 million CSP, Inc., convertible notes that it held. The conversion gave Dataram about 29 percent of array processor company CSPI's outstanding shares, but the results of earnings from this conversion were minor in the first quarter, because of the timing of the action.

systems. Cupertino, Calif.-based Apple will put its logo on the printers and support them with distribution, sales and service teams. Financial details of the contract have not been released, but one source close to C. Itoh says the contract is "Apple-sized."...**Diablo Systems, Inc.**, Hayward, Calif., will make its model 620 132-column, 25-cps printer available to distributors. Introduced to OEMs last fall, the printer is expected to retail for $1595, and will be available to distributors 90 days after receipt of order....

Annual Report

Centronics Data Computer Corp., Hudson, N.H., has released unaudited financial results for its fiscal year ended June 27, 1982. Net sales for the year were $112.7 million, compared with $120.8 million last year. The net income loss was $18.3 million, compared with a loss of $24.5 million last year. Earnings per share were a loss of $2.94, compared with a $4.08 loss last year. The results do not include operations of Centronics's new Line Printer division, which formerly was the printer business of Computer Peripherals, Inc. After that merger in late June, Centronics's balance sheet reflected an increase in net worth from $47.9 million to $86 million this year, and a debt reduced from $69.3 million to $47.8 million. On June 25, the company restructured its credit arrangement with lender banks by executing a $50-million credit agreement and thus increasing available borrowing

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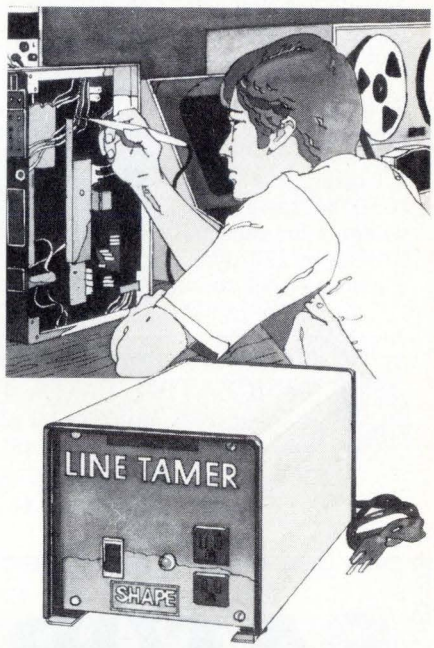

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IBM...WANG...GA...SEL? Yes.
IEEE...INTL...APPLE...RS232C? Yes.

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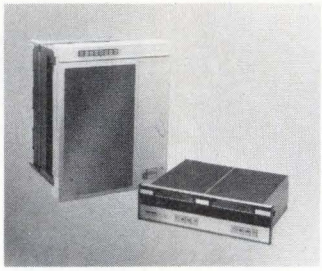

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to $22 million at year-end. The company's losses reflect inventory adjustments of $5.2 million, reserves for consolidation and cost-cutting activities of $3.4 million and foreign-exchange losses of $0.9 million. Centronics officials expect that its Printstation 350 family of dot-matrix printers and the E-Series band line printers, with enhancements and additions, will have a positive impact on sales next year.

Industry Monitor

Vector Graphic, Inc., reports record-setting orders for its new Vector 4 dual-processor microcomputer, outstripping the previous best-selling model by more than two to one. Vector president Frederick A. Snow says orders for more than 400 Vector 4s were received in the first seven days books were open, more than twice the rate recorded last year when the company's—and the industry's—first Winchester-

The Vector 4 microcomputer *is breaking sales records for the company.*

disk-equipped microcomputer was introduced. Additionally, Vector now has 401 dealers, and has signed 10 foreign distributors that may sell $8.6 million worth of Vector Systems.

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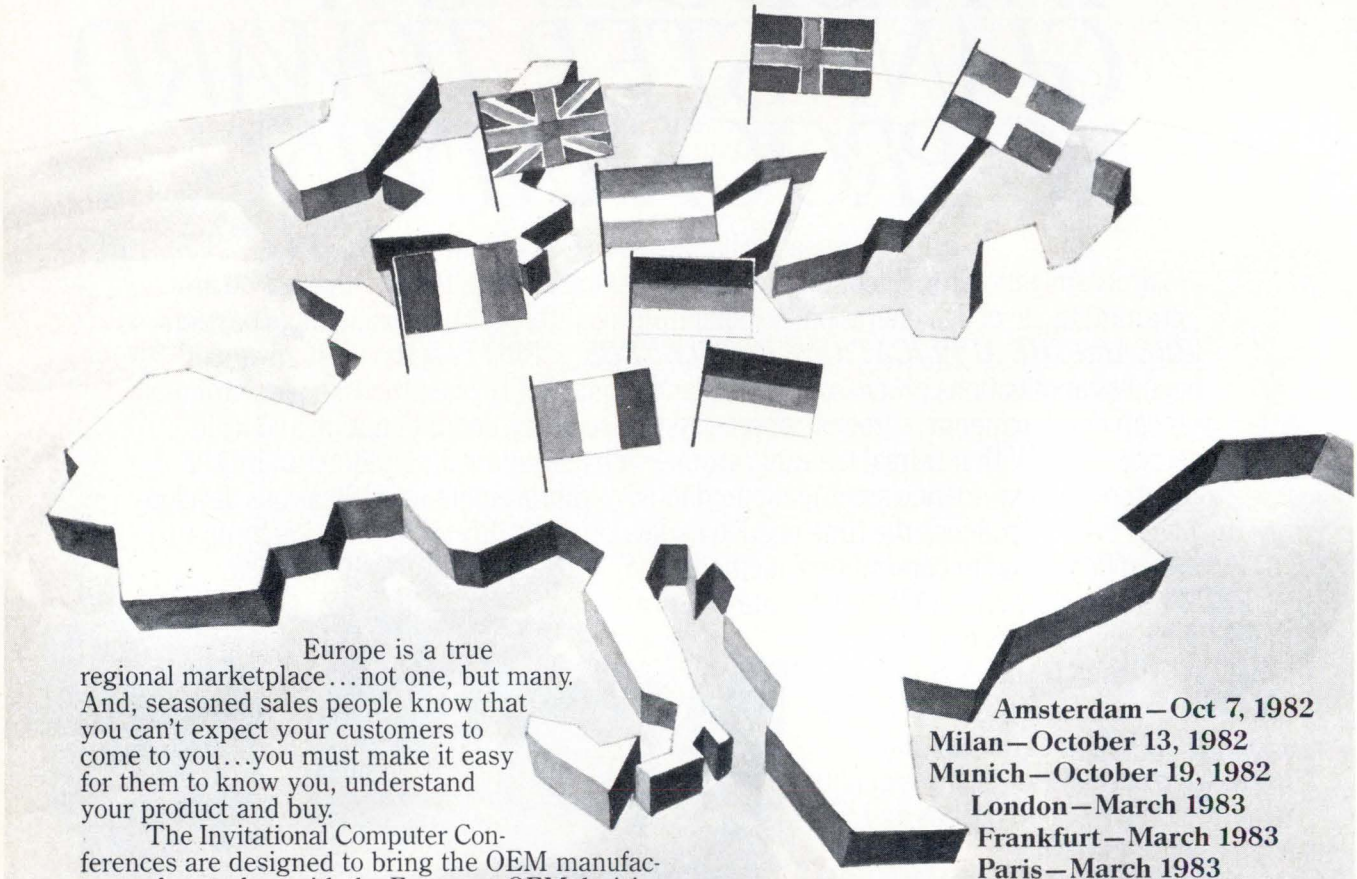

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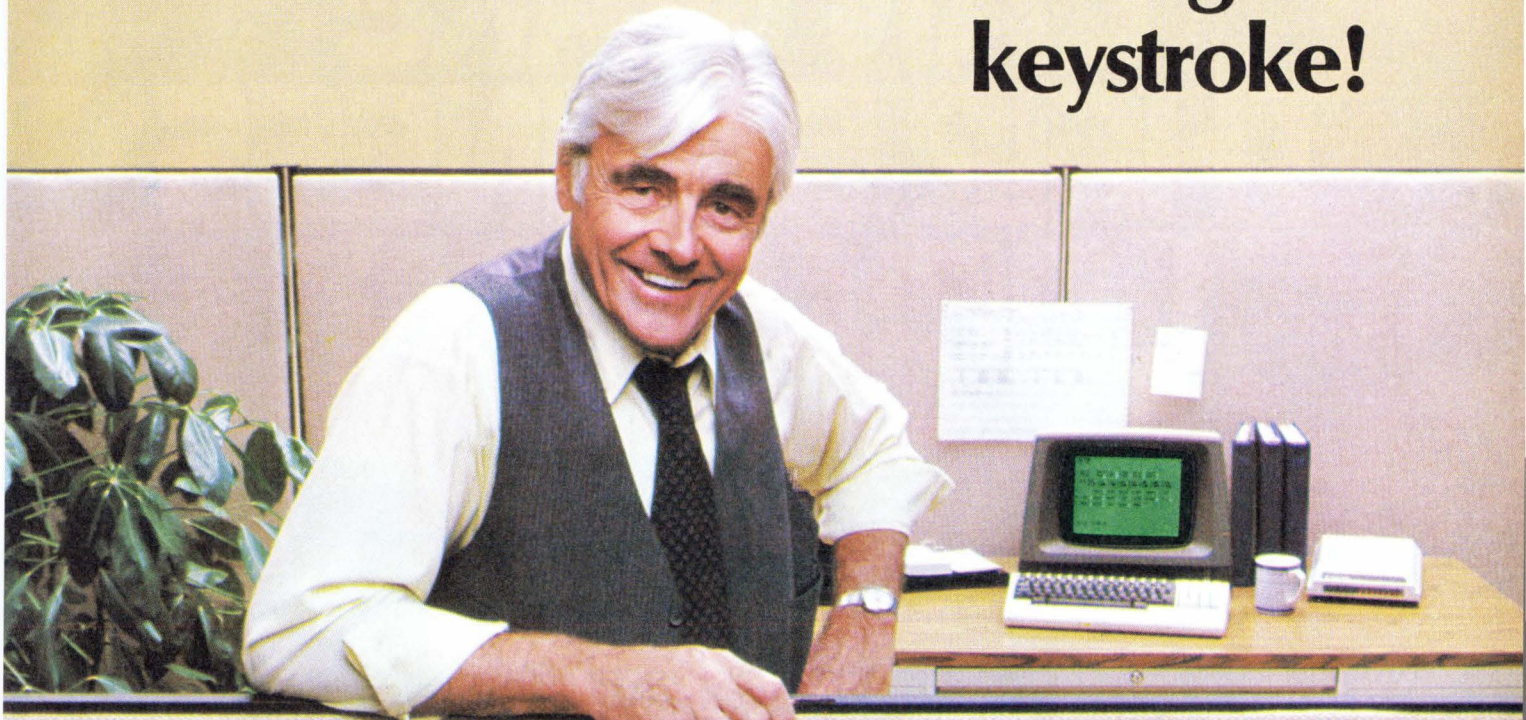

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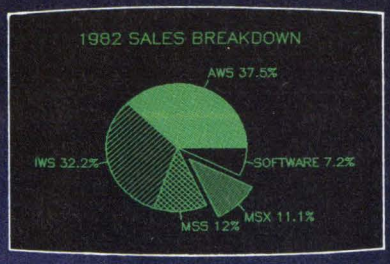

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CIRCLE NO. 75 ON INQUIRY CARD

European firms target U.S. Tektronix graphics market

A color-raster terminal said to be fully compatible with software supporting Tektronix 4010, 4014 and 4027 terminals is one of a group of Tektronix-compatible graphic-display units originating in Europe that will be available in the U.S.

The color-raster Autograph X5A comes from Britain's Data Type International, Ltd. Autograph X5A will be available in the U.S. in evaluation quantities this month from Data Type, Inc., Mountain View, Calif. Data Type, a subsidiary of the British company, began operations early this year. Volume shipments are scheduled for January.

The parent company, based in Wales, started in the graphics business by mounting PC boards for graphics functions inside TeleVideo, Inc., alphanumeric CRTs. The X5A and the monochrome XK1 are the first graphics units designed from scratch by Data Type. Alan Richardson, Data Type sales manager, says that, with single-unit prices of about $4800 and $4200, respectively, the X5A and XK1 are as much as 40 percent less expensive than equivalent units from the company's U.S.-based raster-scan competitors.

Technical features of the X5A include a 512 × 512 pixel memory and the facility to scale down the Tektronix viewing image from 1024 × 780 points to 512 × 390 (2:1). The X5A employs a 14-in. noninterlaced tube and can display as many as 16 colors simultaneously.

Westward Micro Systems is another European raster display builder targeting the Tektronix market. Sales manager Roger Crumpton expects the company to begin selling in the U.S. next year. Outlets are already being explored. Started in 1977, Westward has shipped 600 terminals, Crumpton says. He quotes $3400 for the monochrome Westward 1015, which is software-compatible with the Tektronix 4012. The color C2014 is also 4012-compatible and is priced at $7500. The 1015 provides 640 × 490 viewable points, while the C2014 shows 512 × 392. The refresh rate is 60 Hz.

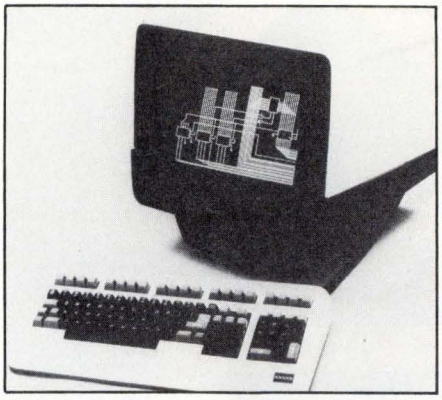
The Westward product line also includes a Tektronix 4014-compatible workstation called the 2019W, which features a 19-in. display and 1024 × 784 viewing points. It is priced at $11,500.

Sigma Electronic Systems, another British company, has tackled penetration of the U.S. market through a deal with Lundy Corp., under which Lundy Electronic Systems, Charlotte, N.C., is licensed to build Sigma's 5000 Series terminals. Based at Horsham, England, Sigma handles its own manufacturing and European sales.

Sigma marketing manager Ray Spiers says Lundy is already building two Sigma units, the T5470 high-resolution monochrome terminal and the T5684 color unit. The Tektronix 4014-compatible T5470 displays 1536 × 1024 points and includes a 15-in. green phosphor CRT. The T5684, a 4010-compatible unit, features a 14-in. screen and provides 768 × 512 points.

Sigma unveiled three new products at the recent Eurographics '82 show in England: a high-resolution monochrome terminal and two color workstations. The T5472 monochrome unit comes with a 20-in. green phosphor CRT, provides Tektronix 4014 emulation and displays 1536 × 1024 points. Both the S5688 and S5484 color workstations come with a 20-in. screen, a keyboard with joystick, an alphanumeric text store and an ergonomic desk unit. The S5484 is essentially a high-resolution version of the S5688.

—*Keith Jones*



Data Type's X5A color-raster terminal *is compatible with software that supports Tektronix 4010, 4014 and 4027 terminals.*

The Westward 1015 graphics terminal *is software-compatible with the Tektronix 4012, and is priced at $3400.*

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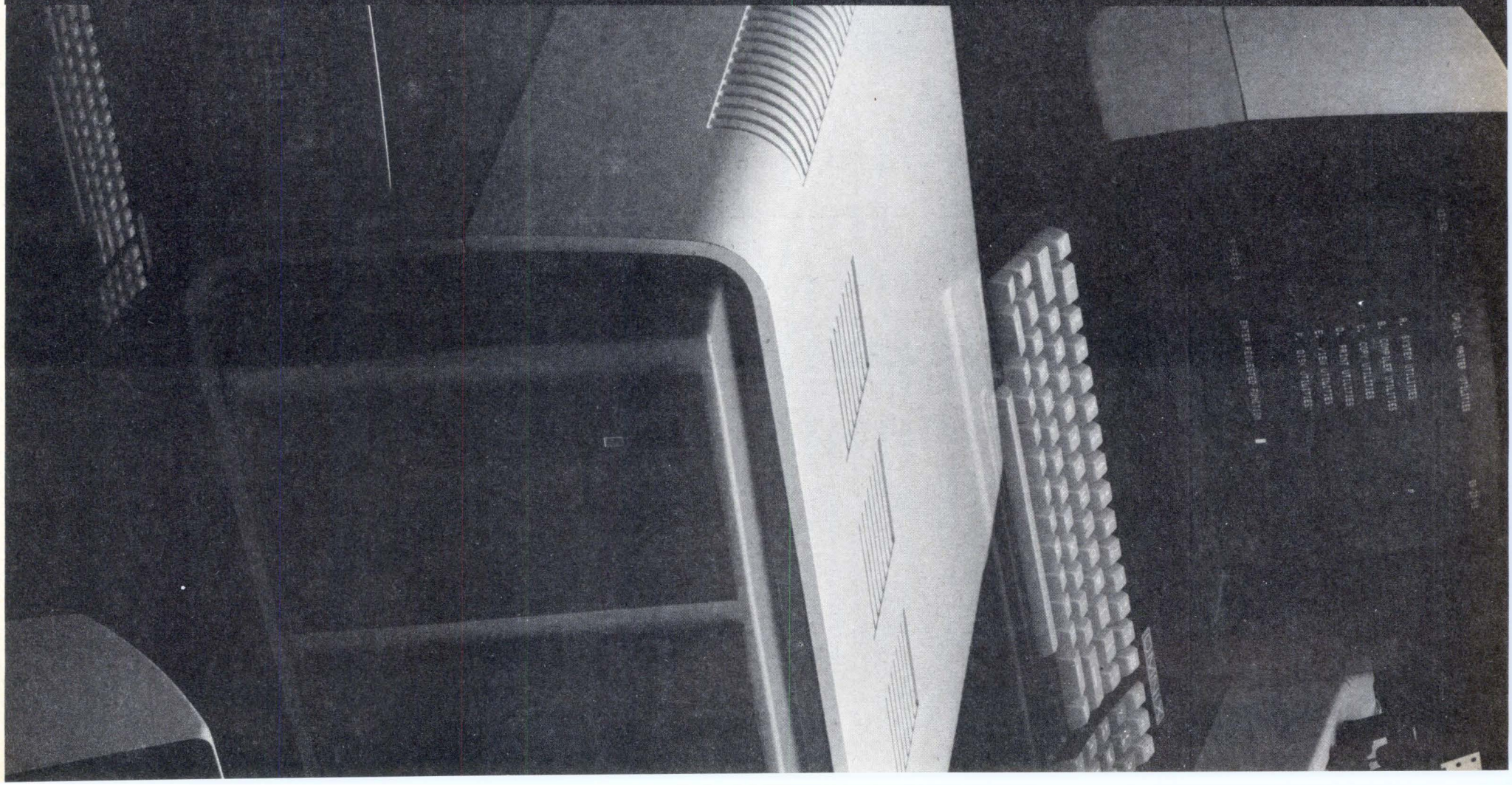

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Ada compiler is aimed at DEC VAX

An Ada compiler that can be hosted by the Berkeley 3 and 4 versions of UNIX and UNIX 32v is in the works. Targeted for Digital Equipment Corp. VAX minicomputers and written in C, the compiler is available only in preliminary form, but a complete version will be released next year, says Dr. Ian Wand of the University of York in England.

The Software Technology Research Center within the Department of Computer Science at York is developing the compiler under a grant from the British government's Science and Engineering Research Council. Another government agency, the London-based British Technology Group, which coordinates the commercialization of SERC-funded developments, should grant licenses for the compiler to U.S. distributors next year, says BTG director Ken Cunningham. "They must be able to support the compiler as well as market it," notes Cunningham. "At the moment, we are sorting out with York the complex question of who owns which parts of the compiler because it was developed by a team."

The preliminary compiler is available in object form only, and it excludes the generics, derived types, private types, sub-units, number declarations and accuracy constraints of the July, 1980, Ada language.

Wand estimates that the product compiles Ada source code at about 700 lines per min. on a VAX-11/780. The compiler produces high-quality code and runs in conjunction with a small run-time system on the VAX, Wand notes. Diagnostic messages can declare that they can be made "verbose or very verbose for the beginner." Wand says that the compiler never will be hosted on a DEC PDP-11 computer.

The York University Computer Science Department has used the compiler in a project intended to gather experience in distributed operating-system development. The department decided in 1979 that the OS should retain much of the functional properties and user interface of UNIX while being distributed across several machines.

Called Personal UNIX-Like System Environment, the York system's kernel is written largely in C, although Ada is used extensively for the rest of the facilities, including the Distributed File System. PULSE development was based on a VAX, using tools that include the Ada compiler. A PDP-11 code generator on the VAX was used for cross-compilation onto the LSI-11 based machines that run PULSE on a ring.

PULSE is designed to run in a network employing the Cambridge Ring technology, in which nodes compete for the use of a packet. PULSE research associate Andy Wellings stresses that York's PULSE system is experimental and will never be commercialized.

Wellings explains that Ada was selected as one of the development languages because York has been closely involved with the evolution of Ada. At the recent European UNIX User Group conference in Leeds, England, Wellings called Ada "complicated to learn and use." But Ada's parallel-processing capability has influenced the design of PULSE, Wellings says. He explains that his team decided to structure PULSE around the Ada task, replacing the process model of UNIX with the tasking model of Ada. All Ada programs will use the same run-time support whether they are part of the coding of PULSE or user application programs written in Ada.

—Keith Jones

INTEL OFFERS ADA COMPILER FOR iAPX 432

Intel Corp. has introduced an Ada compiler for its iAPX 432 micromainframe three-chip microprocessor set. Called Ada 432, Version 1, the compiler is a subset of the Ada language specified by the U.S. Department of Defense. Ada 432 is Intel's first high-level language compiler for the iAPX 432. The compiler's introduction follows recent introductions of the iMAX, the iAPX 432 operating system written in Ada 432, and the 432 cross-development system. Intel sources say the compiler includes many difficult-to-implement Ada features, including separate compilation, generics, "inlines" and machine-level access. Ada 432 is priced at $30,000 in single-unit quantities, including an update to the full DOD-validated Ada compiler, when it becomes available.

APPLE ASKS COURT TO RECONSIDER DECISION

Apple Computer, Inc., asked the U.S. District Court in eastern Pennsylvania to reconsider the August denial of the preliminary injunction in its patent-infringement suit against Franklin Computer Corp. (MMS, September, p. 66). In a similar case, says Apple, the Third Circuit Court of Appeals in Philadelphia decided that object code stored in a computer's ROM circuits is protected under U.S. copyright statutes. That decision was handed down in the Williams Electronics, Inc., versus Artic International, Inc., case. Both cases are similar, in Apple's opinion, because they also charged Franklin Computer Corp. with copying computer programs in ROM form.

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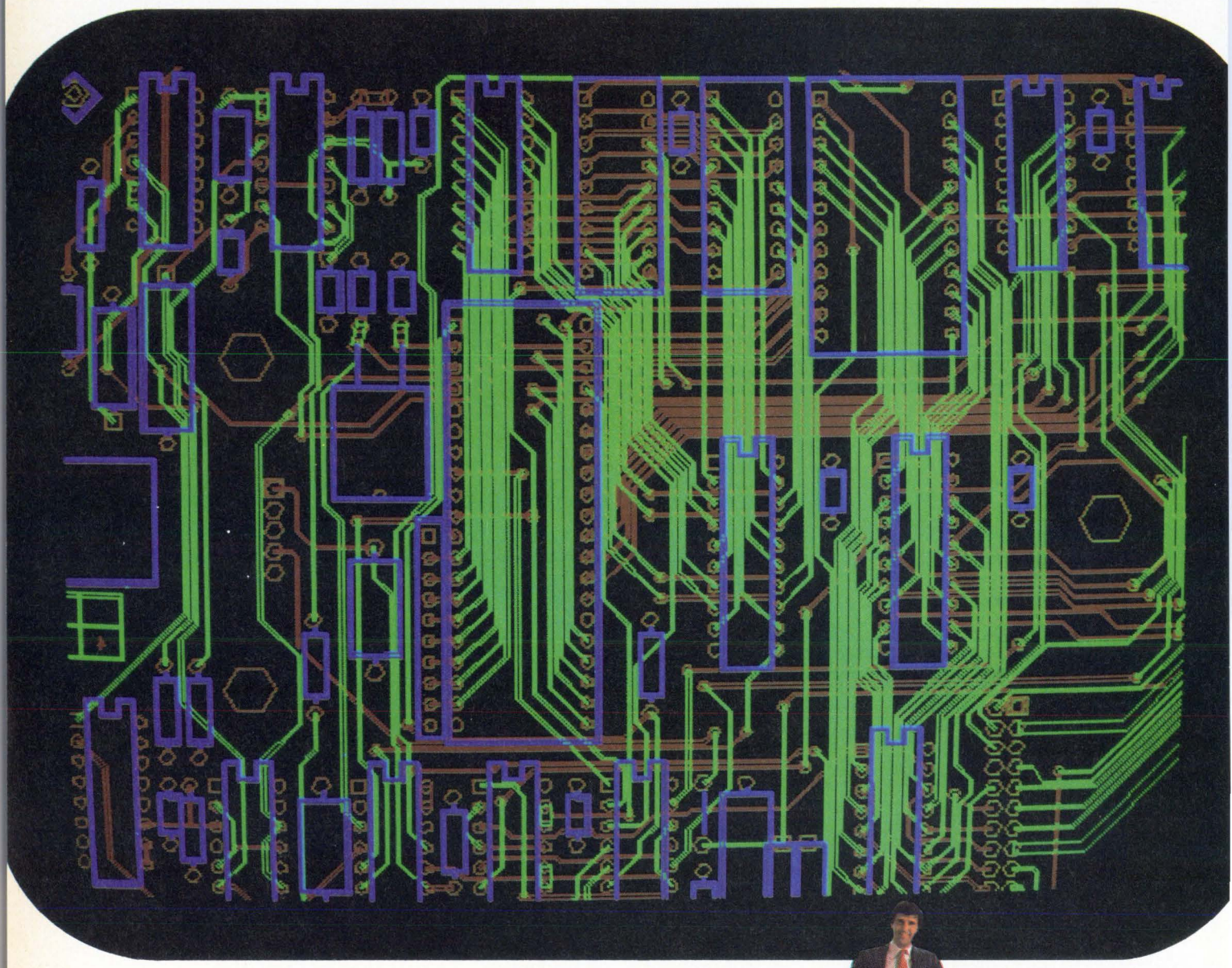

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CIRCLE NO. 79 ON INQUIRY CARD

CDC has chance to buy British peripherals manufacturer

Control Data Corp. favors jointly owned manufacturing facility agreements. Two of its largest are Computer Peripherals Inc., owned with NCR Corp. and Britain's ICL, and disk-drive builder Magnetic Peripherals Inc., owned with Honeywell, Inc. In both cases, CDC holds a majority share. In Britain, through Magnetic Peripherals, CDC owns a minority share in disk-drive manufacturer United Peripherals, Ltd., in which the majority partner, the British government, holds 76 percent.

But under the government's policy to make such companies private, that share will be divested, assuming United Peripherals can run profitably. The purchaser will also be offered matrix-printer and display-terminal manufacturing plants as part of the package. It is not certain whether CDC will pursue the deal, although it is in a strong position to do so.

United Peripherals was established in 1979 to provide British-government-owned peripherals vendor Data Recording Instrument Co. Ltd. with a line of disk drive products to replace the outdated cartridge units that it built under license from Diablo Systems, Inc. Under CDC's agreement with the government, United Peripherals is managed by Magnetic Peripherals, although the government owns a controlling share and carries the company's losses. Moreover, CDC is entitled to sell the Hawk and Phoenix drives built by United Peripherals in England as well as those built at the Magnetic Peripherals plant in Oklahoma City, Okla. CDC's subsidiaries in Europe take about one-half the United Peripherals output.

The British government will divest its share of United Peripherals, Ltd., *and current partner Control Data Corp. is in a good position to assume that part. At the United Peripherals plant, Winsford, England, Chris Birks, a division director within the government's British Technology Group (right), talks with Peter Gregory, non-executive chairman of Data Recording Instrument Co., Ltd., the holding company for the government's share of United Peripherals.*

But United Peripherals is intended to be more than just an offshore manufacturing facility for CDC. A design team at the English company is developing products that could be made available worldwide by CDC. The first is the Meadow Lark 80M-byte, 8-in. Winchester drive with three fixed disks. It complements the U.S.-developed Lark, which has one removable disk.

United Peripherals is running smoothly and is expected to operate at a profit this year on shipments worth nearly $50 million. But the company had a very troubled infancy. It cost the government about $36 million to get off the ground instead of about $14 million as estimated in 1979.

"The $14 million was a grave underestimation," concedes Chris Birks, director of the electronics and information technology division at the British Technology Group, the agency that manages the British government's interests in computer companies. Birks notes that the government this year injected about $21 million into Data Recording, the holding company for the 76-percent share in United Peripherals. The aim was to make Data Recording's books look healthier to would-be purchasers.

Birks expects a sale to be made within the next two years and points to BTG's plan to sell United Peripherals as part of Data Recording. The purchaser will also get Data Recording's other peripherals manufacturing activities, primarily display terminals and matrix printers.

Data Recording expects to build 7000 display terminals this year, mainly for customers in Europe, and is developing a family of ergonomically designed units called the 9000 series that will support ANSI-standard protocols. The company's matrix-printer output target

is 9000 units this year, of which 1000 will be shipped to its one major customer, Decision Data, of which it holds a 15-percent share. With an interface by Decision Data, the units will be sold as plug-compatible alternatives to the 5224 printer offered by IBM Corp. for its System 34 and 38 computers. The 8850 is also available from Data Recording as an OEM product without the IBM interface.

Data Recording's plans also include a 24-needle, single-headed, 132-column printer scheduled for launch next year.

BTG's Birks recognizes that CDC is a strong potential purchaser of Data Recording. Officials at CDC's Minneapolis headquarters neither confirm nor deny plans to make BTG an offer. But CDC's ties with Data Recording through United Peripherals are close. Apart from providing a European facility for Hawk and Phoenix, the United Peripherals factory at Winsford near Manchester, also builds PC boards for three other plants in Europe, each owned and managed by Magnetic Peripherals. All three build CDC's high-capacity Storage Module Drive family.

Even if BTG's holding in Data Recording goes to another company, the future of United Peripherals clearly depends on a continuing close relationship with CDC. Peter Gregory, non-executive chairman of Data Recording, points to a five-year agreement that the two companies—Data Recording and CDC—plan to complete by year-end. CDC has no comment on the agreement, but Gregory hopes that it will include a deal licensing United Peripherals to build CDC's Lark II.

The managing director of the United Peripherals plant, Ed Dougherty, explains that the Winsford design team's work on the Meadow Lark centered mainly on the electromechanical parts. The drive achieves track-to-track access times of 8 msec. and average access times of 25 msec. He says the team will incorporate thin-film-head technology developed by Magnetic Peripherals at Normandale, Minn., in the next version of the Meadow Lark to raise capacity to 200M bytes. *—Keith Jones*

BRITISH GOVERNMENT UNLOADS INTERESTS IN FIRMS

Britain's Labor government of the late '70s acquired substantial interests in numerous computer and electronics manufacturers. Now, the Conservative government is reversing the process. Apart from its plan to sell the Data Recording Instrument Co. with its controlling share in disk drive builder United Peripherals, it wants to sell its majority holding in memory-chip and microprocessor manufacturer Inmos, which has a U.S. facility in Colorado Springs, Colo. The government has already raised more than $179 million from the sale of its large holdings in Britain's biggest computer manufacturer, ICL, and in Ferranti Ltd., a major supplier of military electronics and minicomputer-based industrial-control systems.

But Chris Birks of the British Technology Group notes that the government's policy does not reject intervention. The government still will put venture money, albeit on a minority basis, into computer companies. "We are open to offers from U.S. firms interested in setting up joint deals with other British information-technology firms, such as the United Peripherals arrangement. But we see ourselves acting as a catalyst, then bowing out," Birks says. He points to BTG's office in Washington D.C., which collects "commercial intelligence."

BTG still retains minority holdings in three major British software and systems houses—Computer Analysts and Programmers; SPL International, a major supplier of Digital Equipment Corp. systems; and Systime, Europe's largest supplier of commercial systems based on DEC processors.

RTL/2 real time language released in U.S.

Real-time software as varied as system software, network drivers and process-control coding can be generated for a variety of minicomputers and microcomputers using RTL/2. This high-level language has been used in Europe for nearly a decade and is now available in the U.S. from Intelligent Industrial Systems Inc., Secaucus, N.J.

Along with RTL/2, Micro Magic is also being offered. Micro Magic is a cross-development system enabling large RTL/2 programs for Intel Corp. 8086 and Motorola Inc. 68000-based machines to be generated and debugged by teams of programmers on a powerful Digital Equipment Corp. PDP-11 host under the RSX or the UNIX operating system. The target processor can also be a DEC LSI-11, the basis of the new family of Professional microcomputers from DEC.

RTL/2 and Micro Magic are sold in Europe by SPL International, a leading London-based software house specializing in real-time minicomputer software and system implementation. Jim Fisher, managing director of SPL's research group, says SPL's move into the U.S. market through its deal with IIS has been encouraged by the increasing popularity of Pascal among real-time system builders. RTL/2 is

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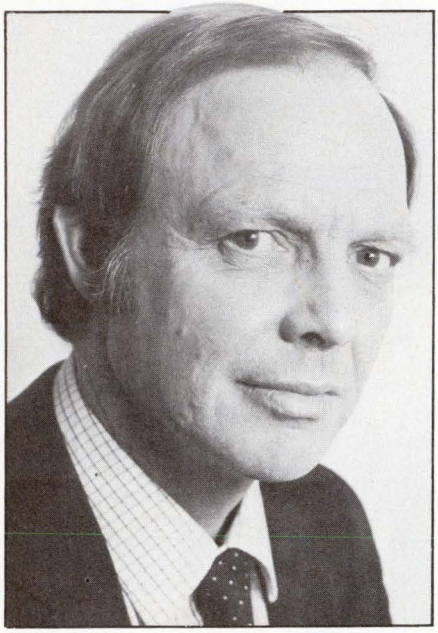
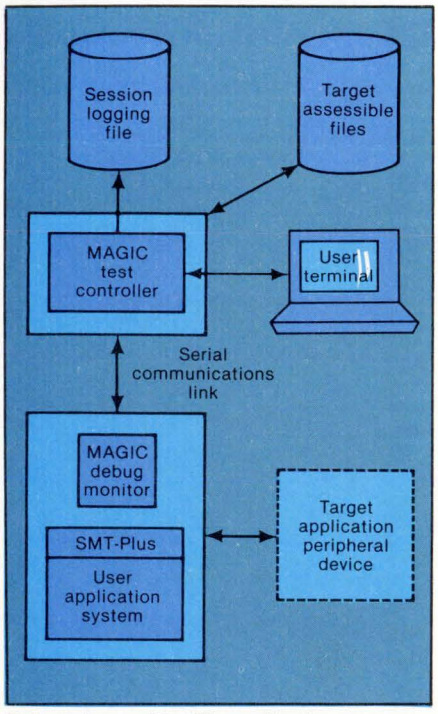
similar to Pascal, but is said to offer greater modularity.

RTL/2 modules are organized into data, procedure and stack "bricks."



Jim Fisher, *managing director of SPL International, is optimistic about U.S. marketing of SPL's RTL/2 real-time high-level language, which is similar to Pascal.*



Debugging with Micro Magic, *a cross-development system from Intelligent Industrial Systems, Inc.*

Stack bricks permit the construction of multitasking programs without outside-language mechanisms and separate the work spaces of tasks.

Fisher notes that RTL/2 is available on all DEC machines ranging from the LSI-11 to DECSystem 10 and 20 mainframes, and 32-bit VAX processors. Operating systems supporting RTL/2 include RT-11, RSX-11M with VMS compatibility and native VMS and UNIX and XENIX on PDP-11s. Other hosts include Data General Corp. Nova and Eclipse machines running under RDOS, Hewlett-Packard Co. 1000 series computers running under RTE4 and Texas Instruments Inc. 990/9900 processors running under DX10. Portability has been improved recently with an easily transported intermediate language, S-Code, to which RTL/2 statements are compiled.

Peripheral builder Anderson Jacobson, Inc., San Jose, Calif., is one of the first RTL/2 users in the U.S. At Imperical Chemical Industries in Europe, which developed the package, RTL/2 is used for process control, machine tool control, production control, order processing, packet switching and air-traffic control.

On the target machines for Micro Magic—8086, 68000 and LSI-11-based systems—RTL/2 is supported exclusively by an SPL developed run-time executive called SMT-PLUS. SMT-PLUS, written in RTL/2, occupies 2K to 6K words, depending on the machine, and supports as many as 255 tasks.

On PDP-11 computers, Micro Magic is aimed at building application programs requiring two or more programmers and occupying more than 8K bytes. Micro Magic enables each programmer to communicate directly with the target machine from a terminal on the PDP-11 host via a 9.6K-bps serial

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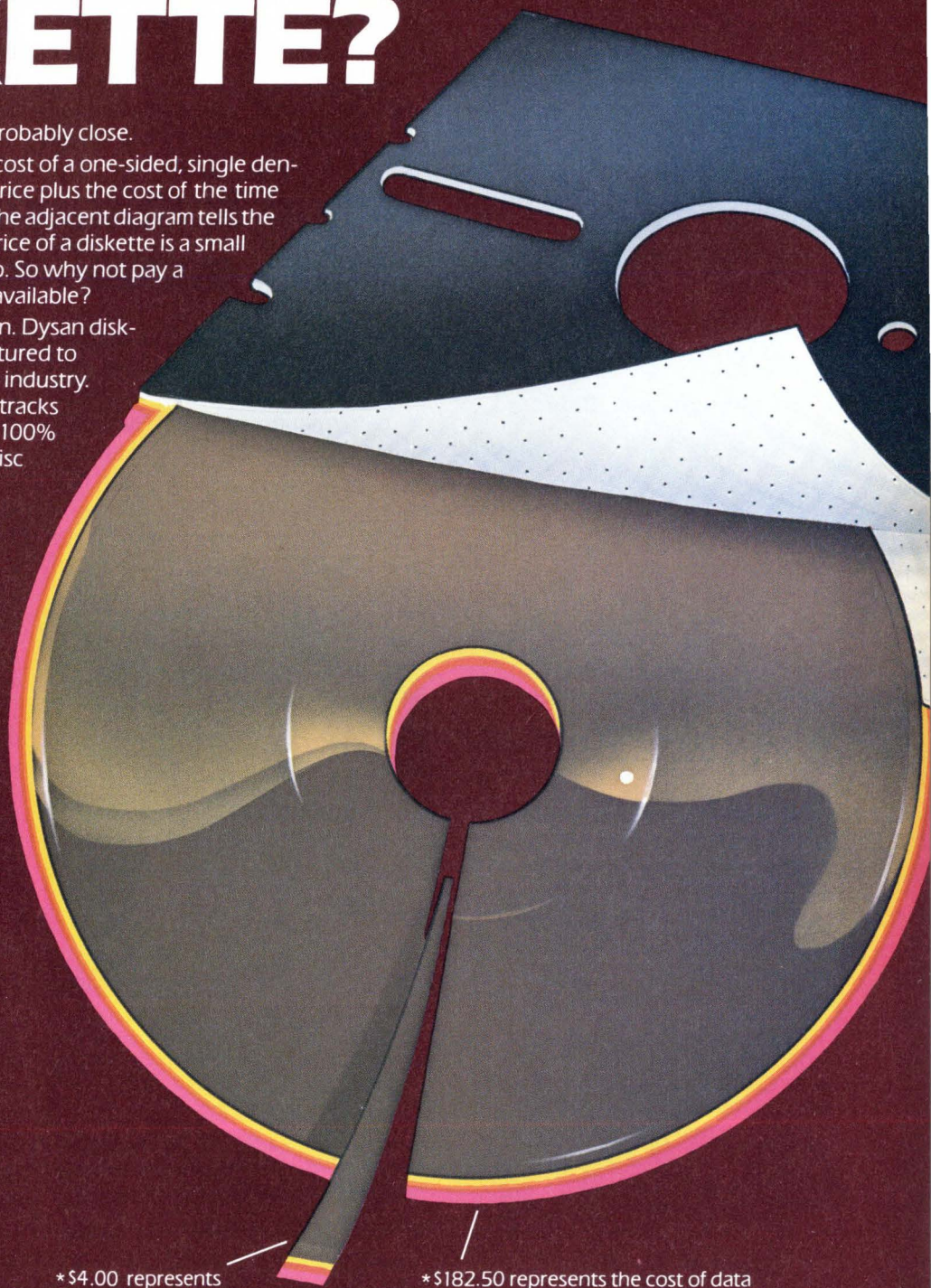

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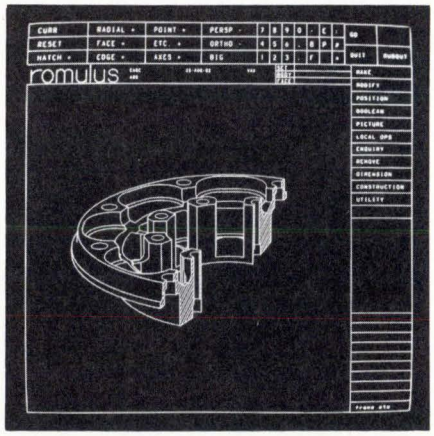
link. A programmer can load application program modules into the target machine for testing. The target can access test files maintained by the host via a ROM-based debug monitor in the target and a test controller package in the host. Modules cross-compiled in the host are consolidated into one executable memory image by a host-based system linker.

Micro Magic was launched in Europe in 1981. More than 50 systems have been sold, says Fisher. The packge, including an RTL/2 license, sells for $10,000. Fisher notes that IIS will concentrate on marketing the product on the East Coast.

—Keith Jones

Evans & Sutherland to market British solids-modeling system

Cambridge, England, a city of little more than 100,000 people, now boasts about 80 vendors of computer equipment, software and services, although many of them are small software houses. The best known computer firm in town is probably personal computer design house Sinclair Research.

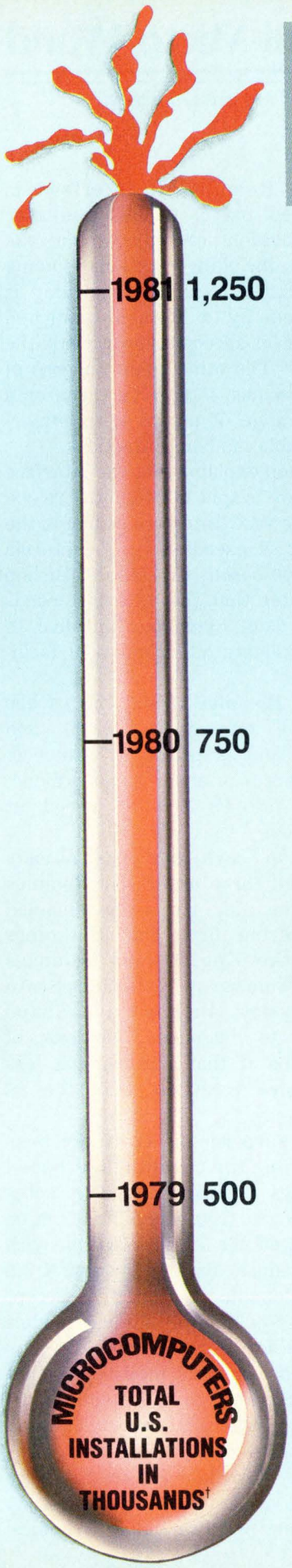


A screen generated by the Romulus II interactive solids-modeling system from Shape Data, Ltd., *Cambridge, England, and sold in the U.S. by Shape's parent, Evans and Sutherland Computer Corp., Salt Lake City. The cursor-selectable menu on the right of the screen is part of the user interface. The object shown is part of the transmission of a Formula I racing car.*

Now, at least three Cambridge-based software companies are addressing the CAD/CAM market in the U.S. Cambridge Interactive Systems and Applied Research of Cambridge are selling powerful drafting packages through Prime Computer, Inc., and the McAuto computer services group, while the Romulus II interactive solids-modeling system from Shape Data Ltd. is available from its parent company, graphics terminal vendor Evans and Sutherland Computer Corp., Salt Lake City.

Shape's Romulus II modeling package will be offered with Evans and Sutherland's PS 300 graphic terminals. While the original Romulus was launched in 1978 without a user interface, Romulus II comes with an extensive user interface tailored for a PS 300 linked to a VAX host. Any VAX user can buy and install the package directly from Evans and Sutherland.

Shape marketing director Dr. Tony Bishop says Shape's interface for Romulus is closely integrated with the fundamental Romulus modeler. The modeler, which runs on the VAX host, provides primitive objects such as cones, cylinders, spheres and torroids and performs Boolean addition, subtraction and intersection of objects. Other facilities include exploded-view generation, hatching, hidden-line manipulation and flattening. The latter is mainly of value if the object is made of plastic or metal sheeting. The modeler can also calculate the center of gravity of an object.



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The Romulus II interface is intended partly to facilitate user manipulation of objects on the screen, including rotation, zooming and scaling. Number crunching is handled by a custom-designed bipolar bit-slice processor inside the PS 300. The other main purpose of the interface is to give the user a wide range of menus with cursor-selectable modeling functions.

Bishop explains that the interface software is split between the PS 300 and the VAX. Interface coding in the PS 300 is executed by a Motorola MC68000-based processor. Bishop estimates that the VAX host needs about 250K bytes per terminal to accommodate all Romulus II facilities.

The Romulus II and the PS 300 package offered by Evans and Sutherland is priced at $100,000. Romulus II is about $30,000 alone, while the PS 300 is priced at $106,000.

Bishop says E&S has already received three orders for Romulus II in the U.S., two from unnamed engineering firms and the other from the Engineering Sciences Department at Colorado State University. Bishop says Shape hopes to introduce versions of Romulus II that will run on less expensive terminals than the PS 300.

Not surprisingly, there are links between the Cambridge-based graphics companies. Shape notes that output from Romulus II can be generated in a form compatible with the Medusa drafting system from CIS. Romulus II can also accept input of polyhedral Medusa models to generate Romulus models.

Medusa has drafting facilities that are said to cover mechanical, building, chemical, electrical and electronics tasks. A user can define symbol libraries and menus with cursor or keyboard selection. A matching program called Graphical

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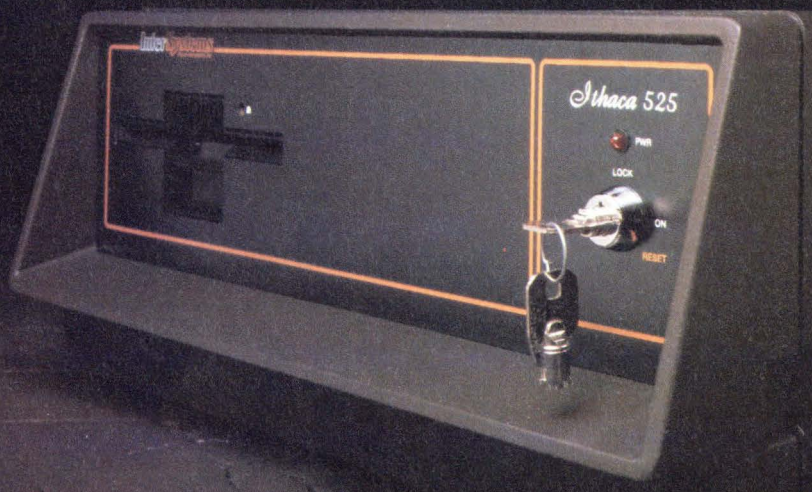

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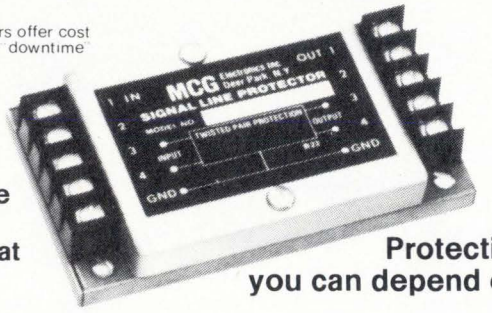

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Medusa can generate models in 3D from a 2D drawing. Modeling features include revolving a polygon around a center line, sweeping a polygon orthogonally through a third dimension to create a solid object, ruling surfaces and a variety of Boolean operations, including merging, subtracting and intersecting shapes.

Prime has the exclusive rights to sell Medusa in the U.S., but CIS Ltd. maintains a small subsidiary, CIS Inc., Cambridge, Mass., to support Prime's activities. Steve Herbert of CIS Inc. notes that Medusa has been mounted on other computers, notably Harris Corp. machines and the Digital Equipment Corp. VAX, although these implementations are not available in the U.S. because of the deal with Prime. Herbert also points to CIS plans to put Medusa on a Motorola MC68000-based machine.

The main offering from Applied Research of Cambridge is General Drafting System, available in the U.S. from McAuto on both Prime and VAX computers. The McAuto operation selling GDS is based at Westminster, Calif., and ARC, like CIS, maintains a U.S. presence for support in Long Beach, Calif., and Niagara, N.Y. ARC chairman Ed Hoskins notes that ARC has sold 30 GDS systems in Britain, mainly on Prime machines, and 30 more overseas, on both Prime and VAX.

The deal between ARC and McAuto was signed last year, and, Hoskins says, about 10 GDS systems have been sold in the U.S. since then. Hoskins describes GDS as "2D with 3D viewing." The greatest benefits of GDS are said to be in editing and in the repetition of graphic elements. In editing, a user can delete, move, rotate, scale, mirror and superimpose drawings as required. —*Keith Jones*

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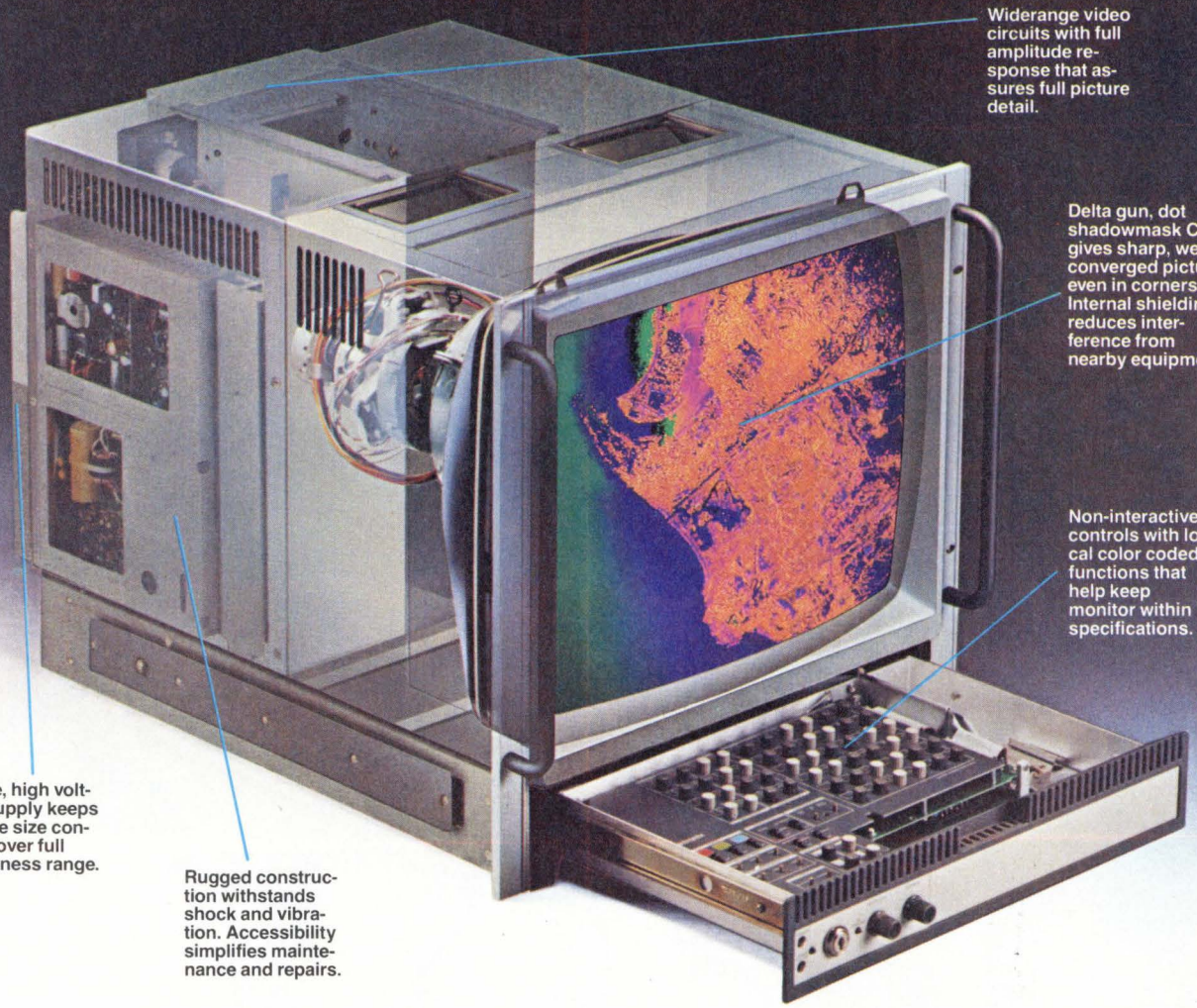

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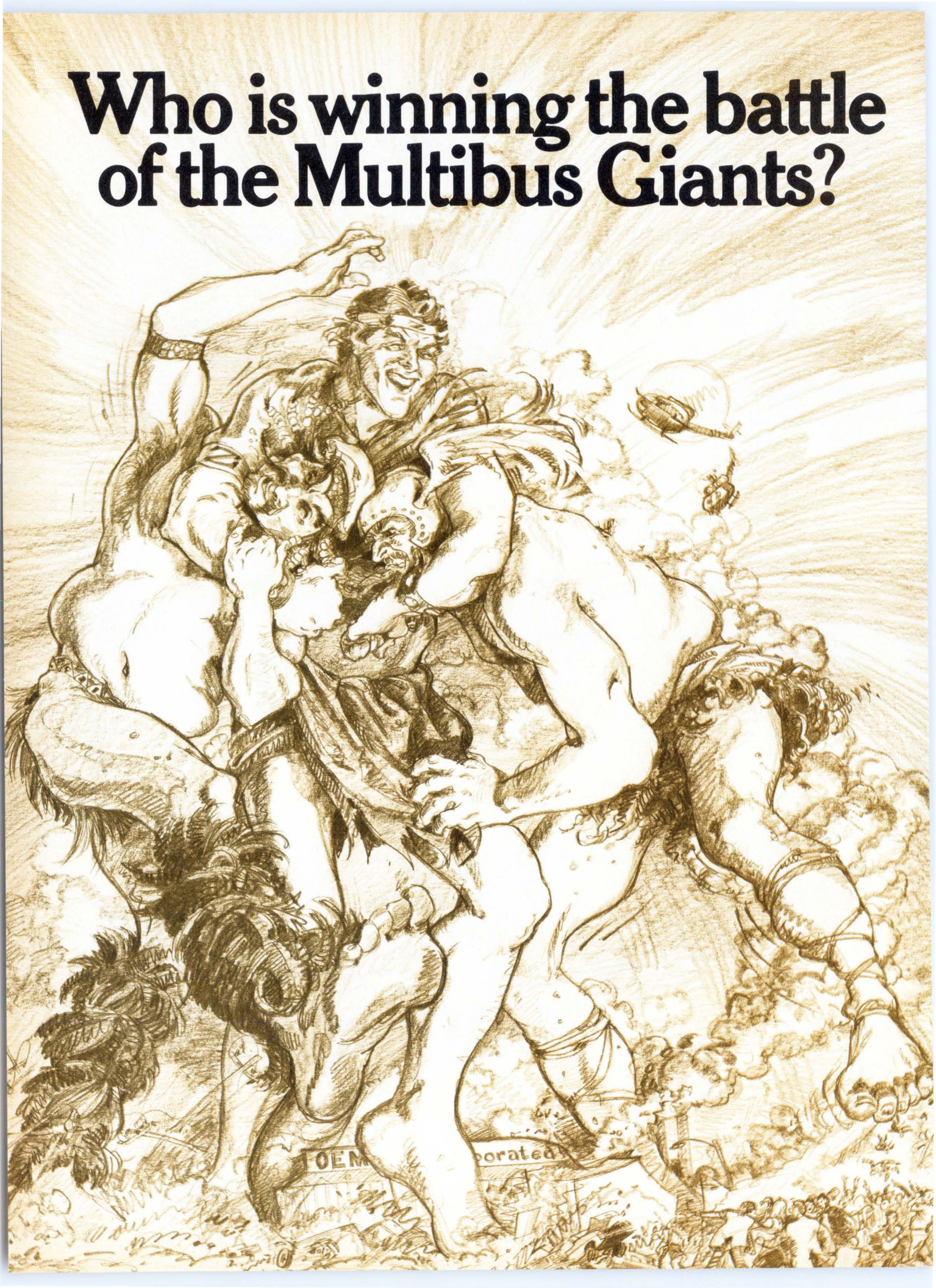

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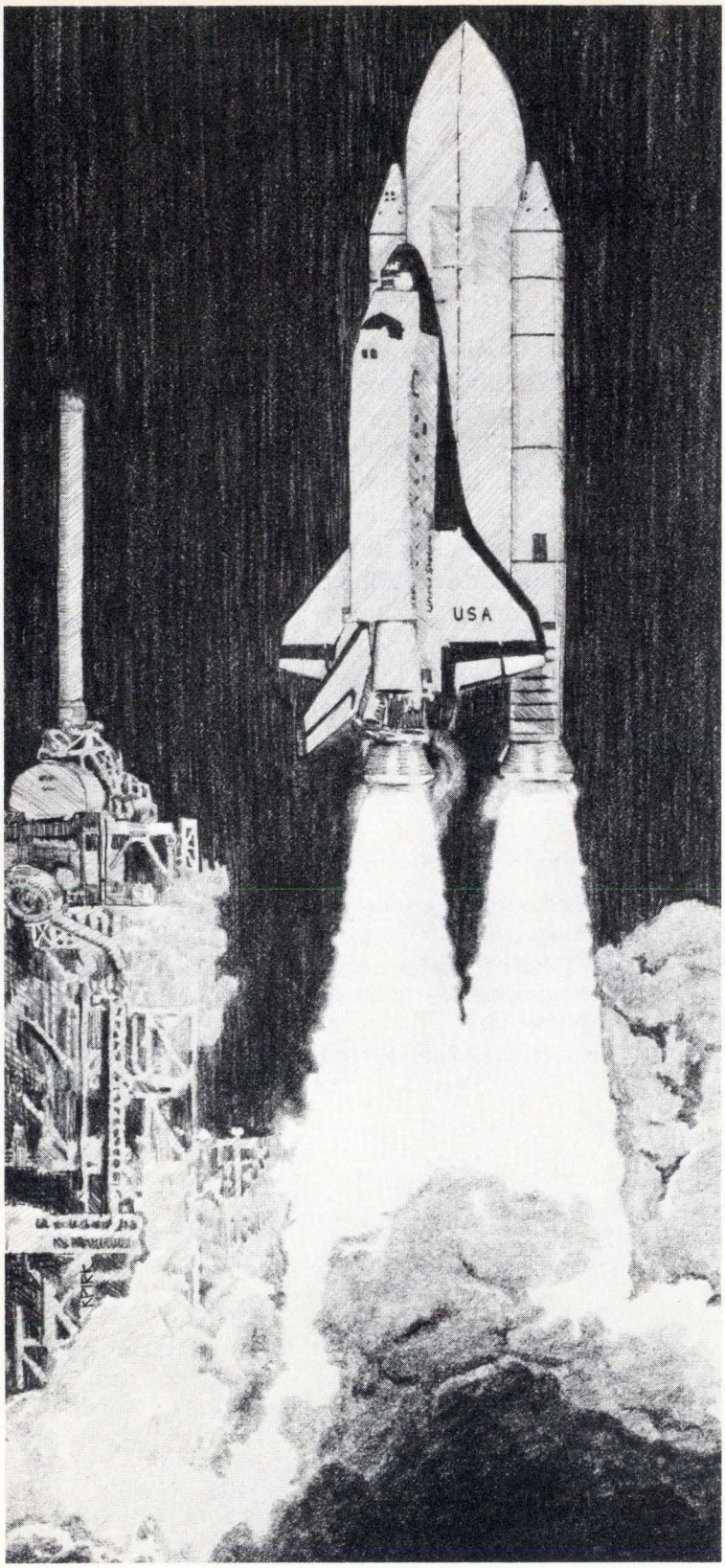

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Publisher's Letter

A new reference that's invaluable

This issue introduces *Mini-Micro Systems' Peripherals Digest*, a product reference section that combines computer-generated product charts, "how-to-select" articles and a directory of manufacturers. We believe that this type of reference is invaluable for the readers of *Mini-Micro Systems* — OEM/system integrators and multi-vendor end users.

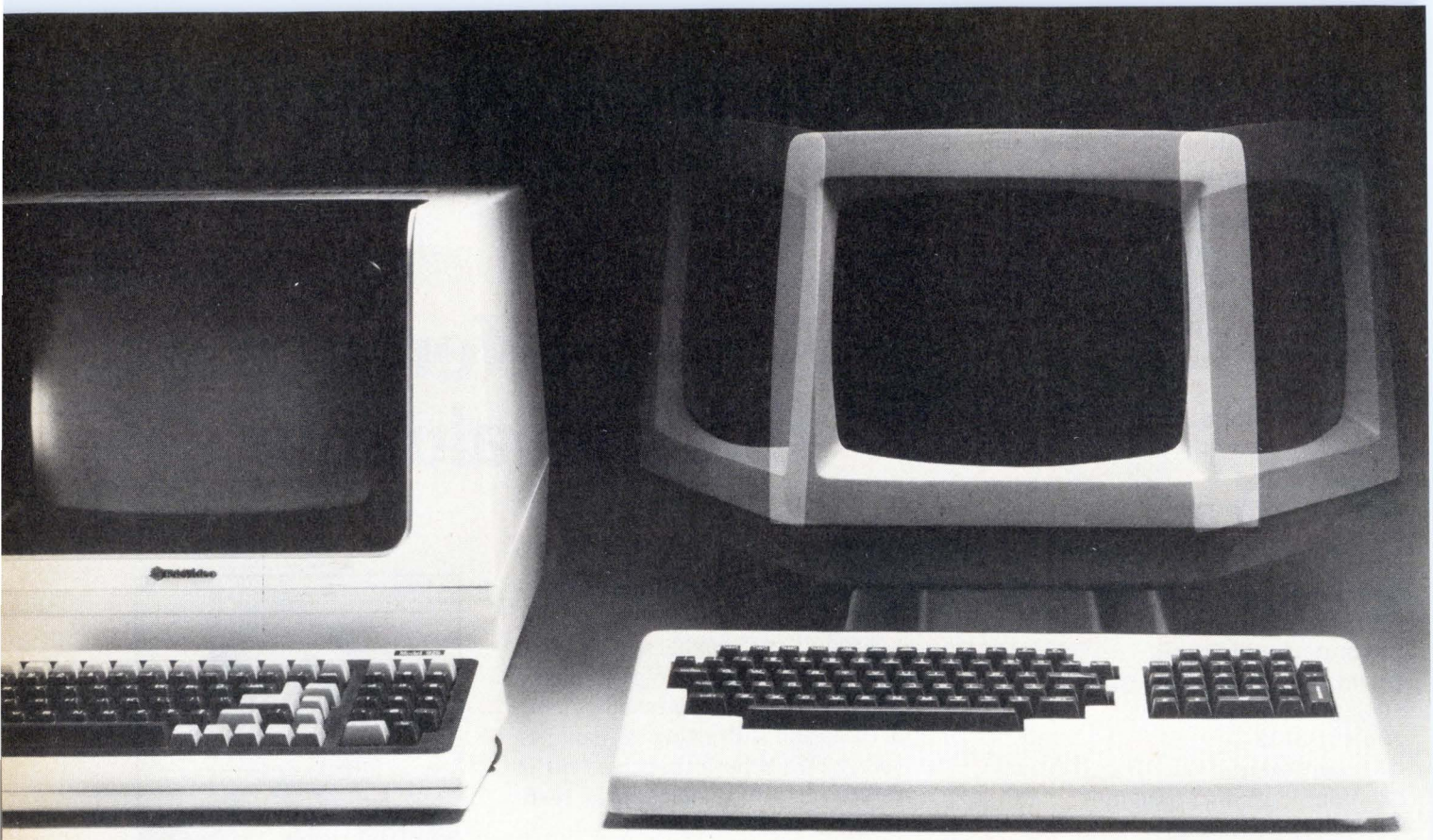
Most of our readers are high-volume buyers of computer peripherals. In many systems, these peripherals represent more than 50% of the hardware cost. Thus, choosing the appropriate peripherals may be more important than the choice of the computer itself. The objective of the *Peripherals Digest* is to help you in making that choice.

Plans call for breaking this section out into two separate *Peripherals Digest* issues in 1983 — a spring edition and a fall edition. They will represent a 13th and 14th issue for our subscribers. As you will note, the *Peripherals Digest* in this issue covers disk drives, CRT terminals, and printers. It will include additional peripherals categories in the separate issues next year.

We would like your comments on this new format — what you like and don't like and suggestions for improvements.

S. Henry Sacks

S. Henry Sacks
Vice President/Publisher



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If you've been considering the terminal on your left, we'd like to help you make the right decision.

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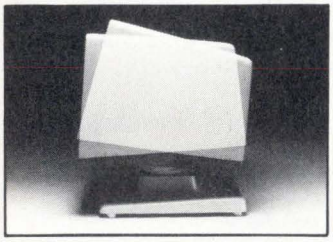

On top of that figure, it would be reasonable to expect an additional charge for the Challenger's exciting ergonomic features—articulated tilt and swivel, detached keyboard, a 10-key calculator style pad for serious business applications, plus a designed in palm rest to reduce operator fatigue.

And when you consider the added value of a 12-month limited warranty honored by an expanding nationwide service organization, you'd likely be prepared to pay even more.

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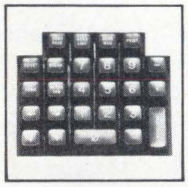

Challenger 135 Highlights

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- ☐ optional integral modem

*Datapro Directory—April, 1982

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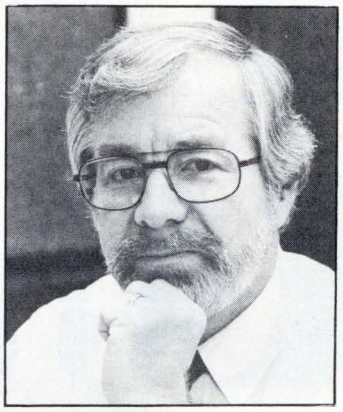
Editorial

Toward a 'sunrise'

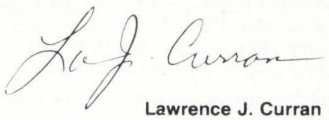


A book published last month offers some excellent insight into the need to sharpen the perception that high-technology industries offer the U.S. its greatest opportunity for continued economic growth. The book is entitled *Global Stakes: The Future of High Technology in America.** The authors contend that America's best hope for economic prosperity depends on how well this nation shifts from an economy that is based primarily on declining ("sunset") industries, such as steel and autos, to one that is information- or knowledge-based. They define knowledge-intensive ("sunrise") industries as those encompassed by computers, microelectronic components, instruments, telecommunications and other information technologies, software and services.

I'd like to summarize some of the other conclusions the authors express, with which I heartily agree:

- The Sputnik-spurred attention to higher education in America has lost the urgency of national commitment that was generated 20 years ago. The result is a serious shortage of engineers that is hampering a fuller flourishing of high technology.
- Worldwide competition in computers presents a serious challenge to the U.S. because the computer industry, like the auto industry, "is an intermediate industry of strategic importance to many other industries."
- Japanese companies have succeeded in global competition because Japan tried to manage supply to match the needs of a world economy, while the U.S. linked demand to domestic political goals, resulting in far too much emphasis on declining industries.
- To regain momentum in the next two decades, policy shapers in the U.S. must shift their emphasis "from a domestic economy based on abundant resources to a global economy with scarce knowledge-based resources....An important part of any national policy will be the role of education and the quality of the work force in high-technology jobs."

The authors of *Global Stakes* don't offer sweeping or simplistic solutions to the difficult social, political and technological problems posed by global competition in the knowledge industries. They stress the importance of education, especially higher education, in the development of the human resources required by those industries. I think their views merit serious consideration.



Lawrence J. Curran
Editor-in-chief

*by James Botkin, Dan Dimancescu and Ray Stata, with John McClellan. Ballinger Publishing Co., Cambridge, Mass.

Letters

AMCODYNE'S NEW LAUNCH

To the editor:

I wish to thank you for the excellent article "IBM's Whitney technology moves into 8-in. disk drive" (MMS, September, p. 22). I wish, however, to clarify a statement in the article attributed to me: "...the company was able to generate 50,000 ramp-loaded head launches before a crash, compared..." Our testing was, in each case, terminated at 50,000 launches since we had reached three times the load/unload cycles the drive would see in a typical five-year product life. The heads never crashed, and we consistently observed less than 5-percent degradation in head/disk output after the life testing. This compares very favorably with 10,000 contact start-stops, a technique used in Winchester technology disk drives.

Implying head crashes after 50,000 ramp launches casts an unfair light on a technology that could become a standard in fixed and removable disk drives.

James H. Morehouse, PhD.
Vice President
Director of Mechanical Development
Amcodyne Inc.
Longmont, Colo.

DYNALOGIC DISCREPANCY

To the editor:

Your August issue ran a survey article on micros entitled "Personal computers: a new generation emerges" (MMS, August, p. 161) in which you state the Hyperion, Dynalogic's microcomputer, sells for $49500, retail. It does not! It sells for $4995 retail.

Lisa Philpot
Marketing Manager
Dynalogic Info-Tech. Corp.
Ottawa, Canada

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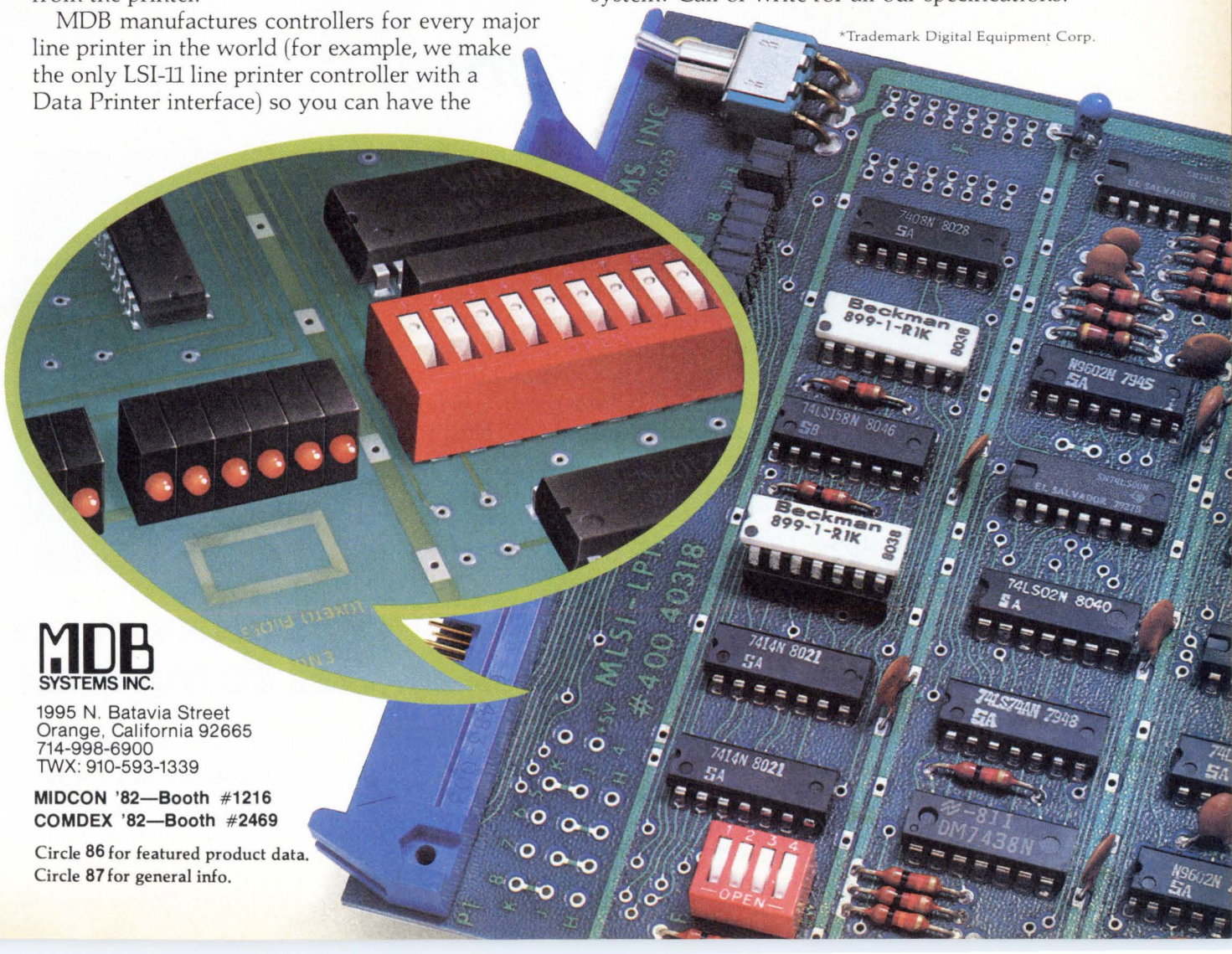

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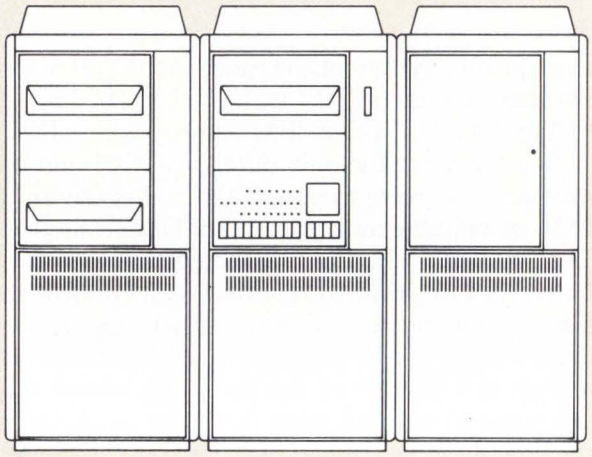

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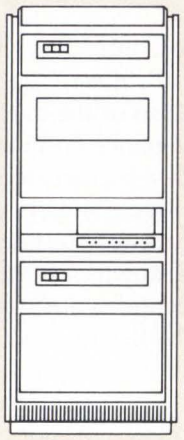

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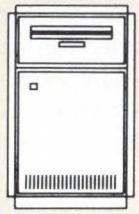

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The Supermicro design provides each user with an 8-bit Application Processor, a Z80A and 64K of RAM. When another user is added, another Application Processor is added. An optional Performance Accelerator allows *any* user to call up a powerful 16-bit 8086 CPU with up to 1MB of RAM—with a simple keystroke command. The Supermicro's unique high speed bus connects all users to a common data base (10 to 128 MBytes), shared peripherals, and the optional Performance Accelerator.

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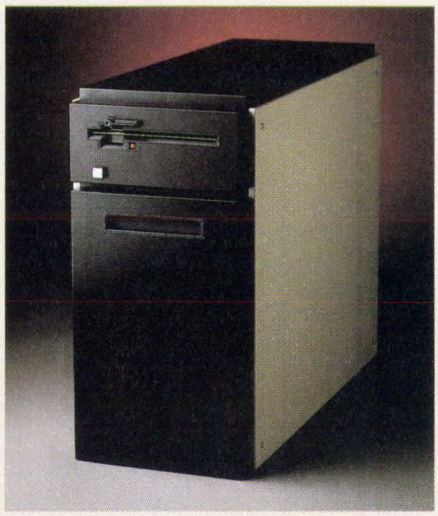

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CIRCLE NO. 98 ON INQUIRY CARD

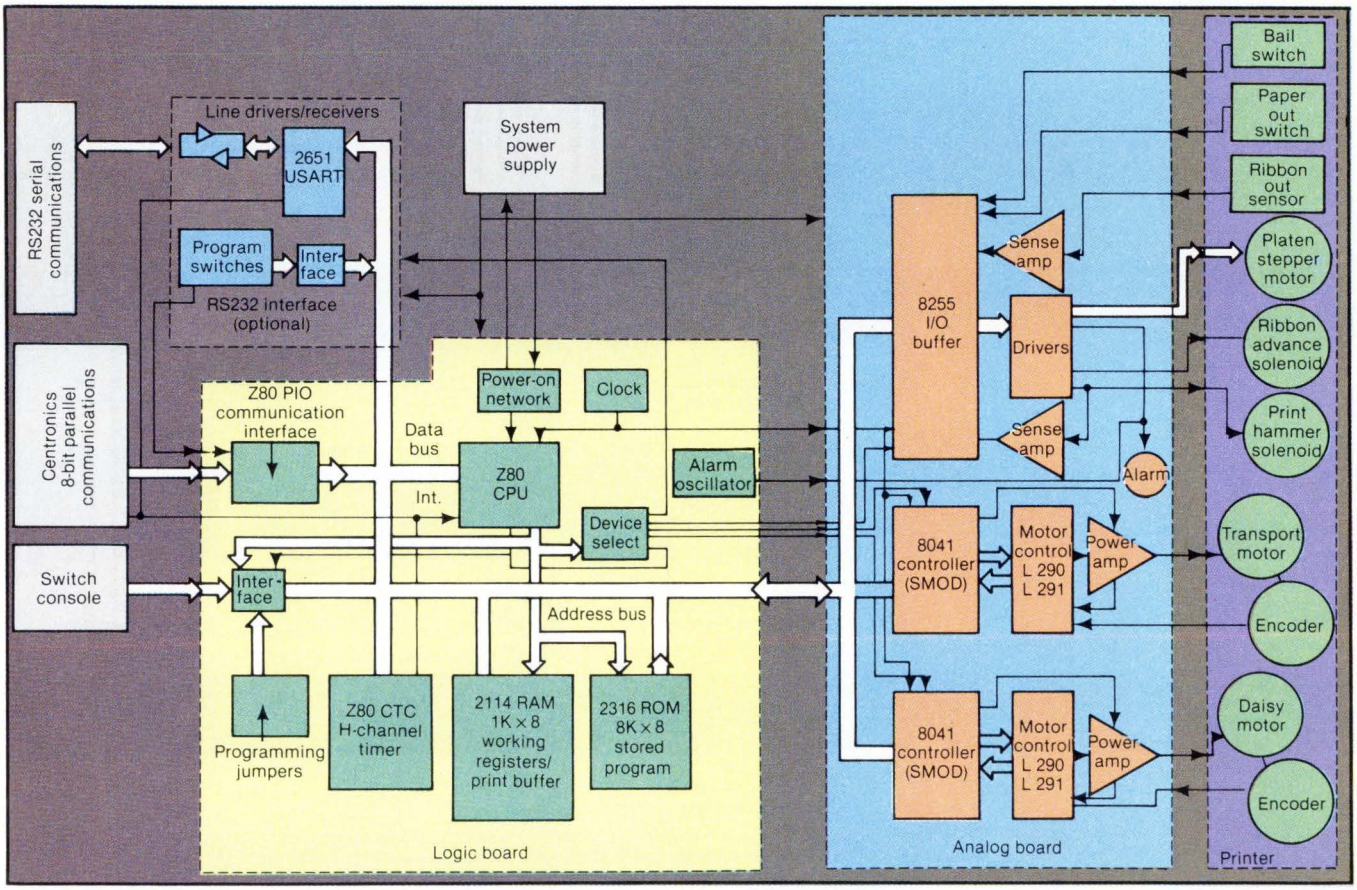
Companies scramble to offer low-priced, letter-quality printers

By Dwight B. Davis
Associate Editor

For years, non-impact-printer vendors have had virtually free rein in monopolizing the business of selling printers to the low-end microcomputer market. However, this domination is being challenged by a number of vendors—many with electronic-typewriter backgrounds—that have introduced letter-quality impact printers priced well below their $2500-plus predecessors. Stimulating this scramble to produce low-end units is the dramatic growth rate of microcomputer systems entering home and business/professional environments.

In the drive to cut letter-quality impact-printer prices, only one company has broken the $1000 barrier passed some time ago by matrix printers. SCM Corp., New Canaan, Conn., suggests a retail price of $895 for its TP-1 printer, and there are reports that the daisy-wheel unit has been advertised for as little as $550. Most other vendors targeting the low-end microcomputer market offer units that supply more features than the TP-1, and carry single-unit prices in the $1200 to $1800 range. The vendors believe that, even at these prices, the impact printers will prove very attractive to many microcomputer users, especially those performing word-processing applications with their systems.

Almost all the inexpensive impact printers achieve their low prices, in part, by operating at speeds considerably below their higher priced counterparts. The TP-1 claims only a 12-cps rate, and most of the other low-end units operate at 25 cps or below. A notable exception is the 45-cps Image I printer recently announced by Primages Inc., Bohemia, N.Y., and scheduled for volume shipments in April at a single-unit price of $1650 (MMS, September, p. 9). Even at the lower speeds, however, the impact printers are expected to



A printer block diagram of Irwin/Olivetti's DY 211 daisy-wheel printer *illustrates the blending of mechanical and electronic components common to impact printers. The printer incorporates three stepper motors for driving the platen, the carriage mechanism and the print wheel.*

exhibit strong market penetration during the next several years (see chart, p. 172).

Comparing typewriters and printers

As vendors move to address the low-end letter-quality market, a face-off has developed between the traditional computer-printer manufacturers, which have moved down to enter the market, and the electronic-typewriter manufacturers, which have moved up to compete. Of the big three impact-printer vendors, Qume Corp., San Jose, Calif., and Diablo Systems, Inc., Hayward, Calif., are particularly disdainful of printers that have electronic-typewriter roots. Even NEC Information Systems, Inc., Lexington, Mass., which bases its new 2000R Spinwriter on a unique electronic-typewriter mechanism from Brother Industries, Ltd., Japan, snubs printers based on traditional typewriter mechanisms. Art Munzig, president of Computers International, Inc., Los Angeles, which incorporates the Brother mechanism in its Daisywriter printer, introduced in May, 1981, also believes the mechanism is far superior to those found in standard electronic typewriters.

While admitting to differences between computer-printer and electronic-typewriter mechanisms, vendors basing their new printers on typewriter components point out that they do modify the typewriter mechanisms for printer environments. For example, Mort Gutman, SCM's director of printer marketing, notes, "We've added a fan to fight heat buildup because no typist is going to go at even 12 cps for very long." Also, unlike its electronic-typewriter progenitor, the TP-1 eliminates the lifting mechanisms that raise the ribbon for each character stroke and lift the correction tape for fixing errors. Such changes make the modified printers much more reliable than standard electronic typewriters, which can function as computer printers through use of add-on interfaces, Gutman says.

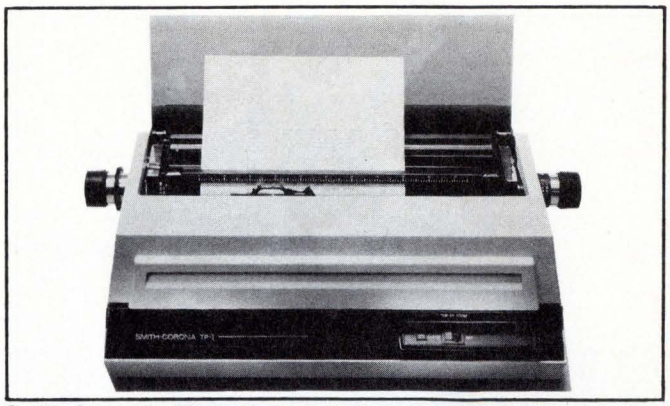
REPRESENTATIVE IMPACT PRINTERS PRICED BELOW $2000

Company Printer	Approximate retail price	Speed (cps)	Print element	Characters/line (pitch)	Buffer (bytes)	Paper feed
Computers International Daisywriter 2000[1]	$1395	16.5	96-character daisywheel	132 (10) 158 (12) 198 (15) 264 (20)	16K (48K optional)	friction (tractor, sheetfeed optional)
Diablo 620[2]	$1995	20	98-character daisywheel	132 (10) 158 (12) 198 (15)	512	friction, tractor (sheetfeed optional)
Facit/Dataroyal 4560[3]	$1395	22	105 to 112-character daisywheel	130 (10) 156 (12) 195 (15)	2K	friction (tractor optional)
NEC 2000R	$1075 (OEM)	20	128-character thimble	136 (10) 163 (12) 203 (15)	256	friction (tractor, sheetfeed optional)
Irwin/Olivetti DY211	$1550	20	100-character daisywheel	132 (10) 158 (12) 198 (15)	1K	friction (tractor, sheetfeed optional)
Olympia ESW 102[4]	$1399	17.5	96-character daisywheel	141 (10) 169 (12) 212 (15)	4K	friction (tractor, sheetfeed optional)
Primages Image I[5]	1650	45	100- and 135-character daisywheel	135 (10) 162 (12) 202 (15)	1K	friction (sheetfeed optional)
Qume Sprint 11/35	$1776	35	96-character daisywheel	132 (10) 158 (12) 198 (15)	500	friction (tractor optional)
Smith-Corona TP-1	$895	12	88-character daisywheel	105 (10) 126 (12)	32	friction

Notes:
1. Model 1500 Daisywriter, an OEM version, includes 4K-byte buffer and either serial or parallel interface and sells for $1250 (serial).
2. Diablo 620 +, which includes automatic sheetfeeder and supplies starter kit, would sell for about $3000.
3. Facit/Dataroyal's 40-cps 4565 printer is $1899 in KSR configuration with RS232 serial interface.
4. Olympia's ESW 103, a KSR unit otherwise identical to the receive-only ESW 102, sells for $1899.
5. When configured with either RS232 serial or Centronics parallel interface, Image I sells for $1695.

One advantage SCM claims over traditional printer manufacturers is greater economies of scale. "Because we share many common parts with our typewriters, we can amortize our costs over a fairly large production base," Gutman says. Another advantage claimed by Gianni Subrizi, vice president of marketing at Irwin/Olivetti, Ann Arbor, Mich., is typewriter vendors' greater awareness of print quality. While some computer-printer manufacturers insist the print quality of their units is superior to typewriter-based units, Subrizi notes, "People refer to Selectric-type quality as a reference point, not to Qume-type or Diablo-type. The typewriter has the quality level that printers claim to imitate."

Nevertheless, Subrizi doesn't dispute the claims by some printer manufacturers that electronic-typewriter-based printers typically don't equal traditional printers in durability and reliability. Paul Shapiro, marketing manager at Diablo Systems, points to several general distinctions between electronic-typewriter and computer-printer mechanisms, noting there are probably exceptions to every rule. "In general, typewriters are not designed for 25-percent duty cycles (2 hours per day)," Shapiro says. "Irrespective of what the data sheets say, they're designed for 2- to 3-percent duty cycles.



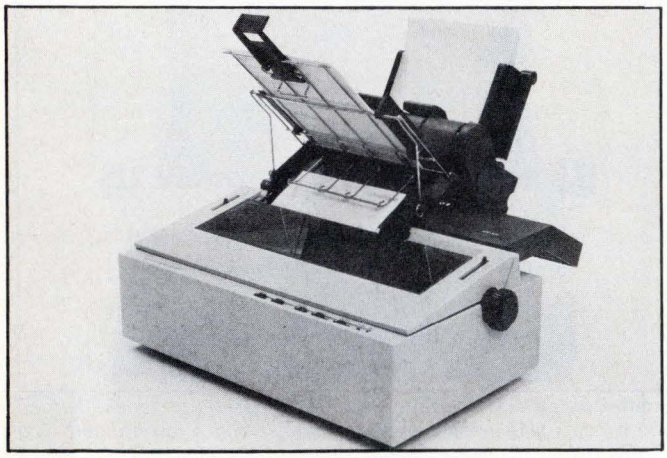
Smith-Corona's TP-1 printer *includes a parallel or serial interface and handles single-sheet paper or forms using a friction feed. The 12-cps unit prints unidirectionally, printing 105 characters per line in a 10-pitch mode and 126 cpl in 12 pitch.*

"Also, the product-goal specification for a typewriter is about 1000 to 1500 hours mean time between failure, whereas the product goal specification for our 620, for example, is 4000 hours." Other typical benefits of computer printers compared to electronic typewriters, he says, are larger print-wheel libraries; less mechanical complexity, which improves mean-time-to-repair statistics; and better paper-handling facilities, such as both cut-sheet feeders and bidirectional and unidirectional tractors, which "improve throughput as much as faster character-per-second speeds."

Randy Hawks, Qume's marketing vice president, says some print-quality distinctions exist between his company's printers and typewriter-based units. Qume printers have a separate mechanism for driving the ribbon advance, he says, which prevents overstriking sections of the ribbon too often. "Typewriter mechanisms have a cog or ratchet that inches the ribbon forward everytime you click through a character space," says Hawks. "That method isn't very precise, so you end up with gradations of print density throughout a printed page."

Qume printers also provide five energy levels for firing the hammer mechanism into the print-wheel spoke, he says, permitting a consistent image whether the character is an "I" or a "W." And because print-wheel rotation is precisely controlled, there is no need to position the daisy-wheel spokes further before

Interfaces	Duty cycle (suggested)	Protocol emulation
Centronics parallel, IEEE-488 parallel, RS232/V.24 serial, 20mA current loop	25% (4000)	Diablo 630; Qume Sprint 9/11; NEC 3500, 5500, 7700; Centronics 737; IBM PC
RS232C serial, 12-bit Sprint 3 parallel, Hy-Type II parallel (choice)	25% (2500 hrs.)	Diablo 630
RS232 serial (20mA current loop optional)	100% (—)	—
RS232/V.24 serial	20% (4000 hrs.)	NEC 3500, 5500 7700
8-bit parallel (RS232, 50-line parallel optional)	N/A	—
RS232 serial, IEEE-488 parallel, Centronics parallel (choice)	25% (3600 hrs.)	Olympia
RS232 serial, Sprint 3 parallel, HY-Type II parallel, Centronics parallel (choice)	25% (3000 hrs.)	—
RS232/V.24 serial	25% (4000 hrs.)	Qume Sprint 5
RS232 serial, 7-bit parallel (choice)	20–25% (10 million characters)	—



Irwin/Olivetti's DY 211 with its optional automatic single-sheet feeder. *The feeder's hopper holds approximately 200 sheets of 20-lb. paper; the stacker's capacity is 400 sheets.*

striking them. Less precise typewriter mechanisms may use a hammer with a fork on each side to center the daisy petal just before the hammer strikes. "This puts a lateral motion on the petal, which is designed to move just forward and backward," Hawks says. "So you get more spoke breakage over time because you fatigue the print wheel much more quickly."

Many of the shortcomings Hawks attributes to typewriter mechanisms can be tracked to the use of stepper motors, he says. Higher priced computer printers typically use servo motors, which Hawks claims are much more precise and reliable than steppers. To maintain the highest possible speed, stepper motors are fired as quickly as possible, he says, "which creates a much more destructive force on the mechanical carriage assembly than a servo-driven assembly, which can be accelerated and decelerated across the carriage advance and return."

Advances in stepper motors

In response to Hawks's assertions, most low-end impact printer manufacturers claim stepper motors can be just as precise and reliable as servo motors when operating at the lower speeds common to their devices. Even Shapiro at Diablo, which invented the first servo-based daisy-wheel printer, says, "Stepper technology is not the latest and the greatest, but it will be an interesting and exciting area over the next couple of years." The Diablo 620 uses stepper motors, "and it has no problem in meeting our print-quality standards or in performing such operations as proportional spacing."

One new approach to stepper technology is the Brother mechanism employed by the Daisywriter and the 2000R Spinwriter. Rather than the typical rotary stepper design, Brother produces a linear stepper mechanism. With the linear motor, "The carriage glides over a chrome-plated steel bar magnetically, so there is no mechanical part that is touching," says Computer International's Munzig. This design eliminates cables, belts, wheels and pulleys, he says, and rather than banging into a physical stop at the end of the carriage cycle, "it's stopped magnetically, so it's like having a cushion on the end."

Computer International's competitors admit the linear stepper design is interesting, but they caution that it has yet to prove itself extensively in the market. David Chiang, director and vice president of computer systems at Primages, cautions that the reliability of any stepping motor depends upon the quality of the manufacturing process used to produce it. "Rotary parts are always easier to make than linear parts," he ays, "and it's very hard to make a linear stepping motor inexpensively."

Rather than trying to redesign standard stepping motors, Primages chose to improve the control over the existing designs. The speed limitations associated with stepper motors result from oscillation problems that occur when the motors are driven at higher speeds, according to Primages. Using patented techniques developed by MCC Associates, which evolved into Primages, the company claims to limit stepper oscillations to less than 1.5 arc min. and to dampen the oscillations to a negligible amount within 3 msec. of stopping. This control of the stepper motor driving the print wheel permits the unusually high stepper-printer speed of 45 cps. And, Chiang notes, even though the Image I uses standard stepper motors, the machine uses no gears or pulleys. "We couple our lead screws directly onto the motor shaft," he says.

An intelligent debate

Mechanical differences aren't the only dispute between makers of impact printers. Munzig has stirred a debate with his claim that the model 2000 Daisywriter "is the first intelligent letter-quality printer." Competitors say their devices can do all the Daisywriter can do, but Munzig disagrees. He draws a parallel between printers and CRT terminals: "I can concede that some other printers are partly smart, but if they're smart, we're intelligent."

Munzig bases his claims of Daisywriter intelligence on the functions provided by the proprietary Computer-Optimized Printer Interface and Emulation System (COPIES). Among other functions, this Z80-based module provides most major protocol emulations, allows dumping a full-screen CRT display to the printer with no handshaking, performs various diagnostic routines, automatically selects baud rates and RS232C protocols,

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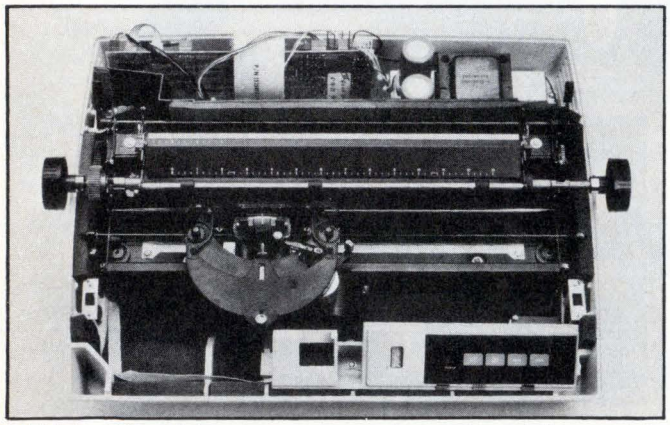

Diablo's 620 printer *(cover removed) consists of five modular subsystems, a design that makes the unit very reliable, according to the company. Mean-time-to-repair for the unit is just 15 min., the company says.*

handles various printing functions and recognizes more than 75 software commands. "Our printer is virtually a stand-alone word processor," Munzig says.

He also claims that the resident intelligence, in conjunction with an unusually large printer buffer of 16K or 48K bytes, permits throughput rates that rival printers with much higher cps ratings. "We can usually beat a 40-cps printer, even though we're technically going only 16.5 cps," he says. However, Irwin/Olivetti's Subrizi questions Munzig's claim that small printer buffers can cause delays when the buffer must wait for the computer to down-load more data. "With just a 1K-byte buffer, a 20-cps printer takes about 50 sec. to empty the buffer," Subrizi notes. "That's so long compared to the processing speed of any processor, that the host can turn its attention to the printer every few seconds, refill the buffer in microseconds and go back to its business."

Subrizi also points out that, while printer intelligence is important when the unit is configured into a new application, much existing computer software can't take advantage of the intelligence. "Sometimes, an intelligent printer has to be made to look stupid, because the host system's software expects a stupid printer on the other side of the connection," he says. "So you want to be able to do both."

Defining/reaching/servicing the market

Aside from having the common thread of a word-processing orientation to bind them, the different players in the impact-printer market are targeting several distinct markets and employing different distribution routes to reach them. SCM, which plans to add features to its TP-1 while holding down its price, will focus on the high-end home market and the low-end business market, says Gutman. "Basically, we're looking at people who must do something under 50 pages of word processing per day. We won't be going after the very low-end home market, and we're not going after the Qumes, Diablos and NECs of the world."

SCM markets the TP-1 primarily through retail outlets, and has agreements with the ComputerLand chain and with about 240 independent stores. Gutman also claims to have some OEM buyers, and hopes to increase that portion of the printer's business.

Irwin/Olivetti is aiming its low-end DY 211 printer at small-business users of personal computers, Subrizi says. "We expect to get the printers certified for use with various personal computers and to sell them in conjunction with the different systems." he says. Although the printers are primarily sold through OEMs and distributors, Subrizi says that distribution policy is being reevaluated following Olivetti OPE's recent merger with Irwin International. "We will be ending some of our distributor arrangements and will approach more dealers directly," he says, "very much as Epson and Apple Computer, Inc., have done."

Munzig, who believes the Daisywriter can fill 80 percent of all impact-printer applications, has no plans to expand Computer International's printer line. The company markets an OEM version of the printer with a 4K-byte buffer and parallel or serial interfaces. "Outside of the U.S., we have exclusive distributors in each country," he says. "In the U.S., we sell to major OEMs through manufacturer's representatives. We also sell through 15 regional distributors who, in turn, sell to computer stores, system integrators and small OEMs."

At NEC, which was scheduled last month to begin shipments of its $1075 2000R printer, Bruce Thatcher, director of product marketing, says, "We think it is feasible for us to build reliable printers essentially as we always have and bring them down in speed and into the under-$1000 price range. We won't go below 15 cps, however, because we think anything below that speed is not viable for mixed data- and word-processing applications."

NEC sells its products through OEMs, distributors and retail stores, including ComputerLand, IBM Product Centers and Sears/Roebuck. Thatcher says servicing the broad, low-end printer user base will be difficult, and says the service problem reinforces the need for reliable products. "If a retailer sells it now, he also provides the servicing, an arrangement that has proved only modestly successful," he says.

Diablo's Shapiro, who says electronic-typewriter-based printers are best suited for the home/hobby market, won't comment on his company's plans for future low-end products, but indicates Diablo is interested in using such products to snare new users into its

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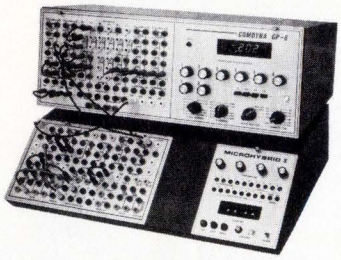

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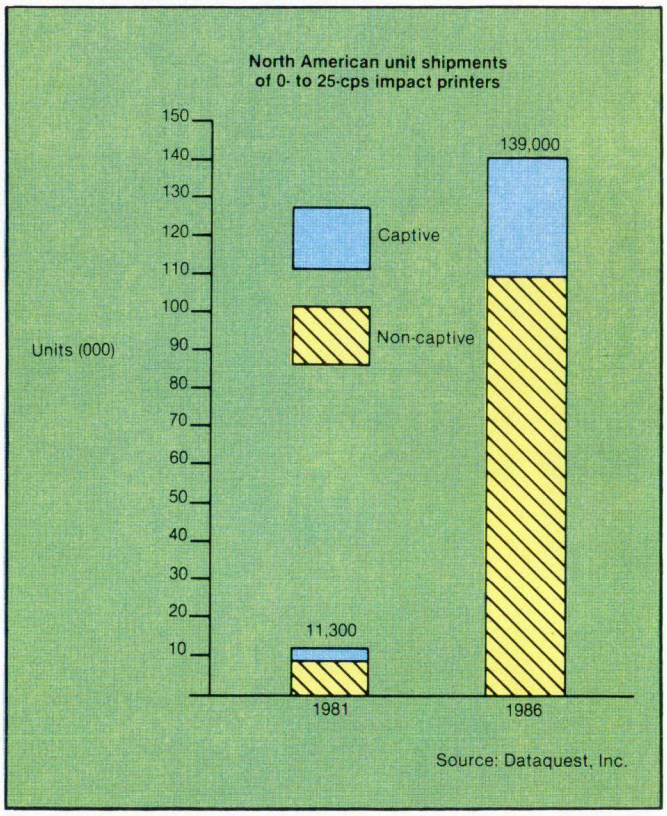

North American unit shipments of letter-quality impact printers operating at 0 to 25 cps will grow *at a 65.2-percent compounded annual rate between 1981 and 1986, according to figures from Dataquest Inc., Cupertino, Calif. The dollar value of the shipments will increase about 50 percent annually, growing from $26.6 million in 1981 to $202.9 million in 1986. Dataquest says 69 percent of the 1981 shipments were made by noncaptive printer manufacturers; this share will grow to 80 percent by 1986, the research firm predicts.*

product line. "First-time hobbyist users tend to become professional workstation users," he says. "IBM has taught all of us that if you seize the low ground, for example, with the Displaywriter I, you are then privileged to be in the path for upgrades to higher level products."

Many printer buyers will purchase their units based solely upon the purchase price, admits Qume's Hawks, who says a better buying criterion is the printer's total life-cycle costs. But because "the under-$1000 price represents a psychological barrier that will sway many customers," Qume is considering introducing products in that price range. "The technology to get there is no secret," Hawks says. "But we would want a product that represents Qume's position in the market—that keeps the quality of the printer, the quality of the print, the reliability and so on at a level appropriate to the price. We don't want to lose the reputation we have worked so hard to build by putting out a printer that is inappropriate for even home users." □

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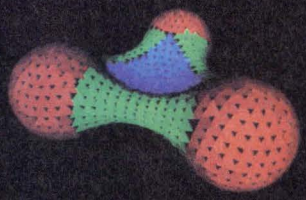
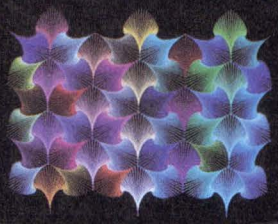


"Three Atoms" Courtesy of Greg Abram, University of North Carolina at Chapel Hill



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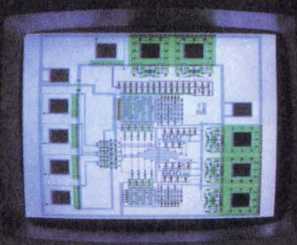

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CIRCLE NO. 103 ON INQUIRY CARD

ANSI graphics standards coalesce around international kernel

By Kevin B. Shrehlo
Associate Editor

Although the American National Standards Institute hasn't finished cooking its alphabet soup of computer graphics standards—NAPLPS, VDI/VDM, PMIG, GKS, X3H31 and IGES—industry appetite for the still-murky broth already seems strong (MMS, September, p. 47).

The key and most controversial ingredient in that recipe—because the flavors of PMIG, X3H31, VDI and, consequently, of graphics functionality will change to complement it—is GKS. Yet GKS has only recently been tossed into the pot to replace ACM SIGGRAPH's Core standard, a move questioned by some participants, who say it makes little sense to discard a proposal with U.S. market momentum in favor of a European equivalent that has never been commercially implemented. But even these critics concede that the proposed ANSI standards will benefit both industry and users via reduced cost and greater portability of graphics applications.

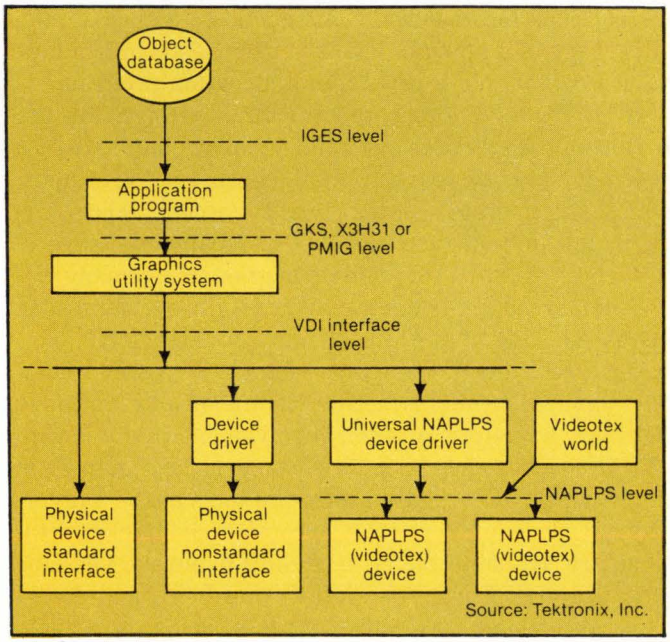
Each of the proposed standards is an interface between levels of the layered architecture of a computer-graphics system (see chart). The pivotal level in the history of graphics standards, because it defines and limits what a computer is capable of graphically, is the interface between graphic utility systems and application programs. The Core proposal, which falls at this level, and its heir apparent, GKS (graphical kernel system), are not misnamed.

The seeds of standardization

The history of computer graphics dates at least to 1951 and the dual 16-in. displays of the Massachusetts Institute of Technology's Whirlwind computer. But as late as 1965, only about 100 refresh displays were in use in the U.S., and these had widely varying instruction sets. Consequently, software was tied to use of one display. In 1968, Tektronix, Inc., introduced the 4010 Direct View Storage Tube Display, which cost less than the refresh displays then in use by more than an order of magnitude. The 4010 and, later, the 4014 DVST soon had large installed bases. Consequently, Tektronix's Plot-10 software, a collection of vector-oriented drawing commands that ran on these displays, became a de facto standard that is still important today. A similar de facto standard developed around CalComp's plotters in the U.S. during the 1960s.

But software tied to particular hardware devices needed rewriting to take advantage of new hardware developments. This factor weighed heavily in the decision of a 1974 international graphics workshop in Malmo, Sweden, that no known computer graphics system was suitable for a standard. In April of that year, ACM SIGGRAPH established a Graphics Standard Planning Committee with the charter of developing a set of standard graphics primitives (basic drawing constructs such as lines, text or area fill) to allow creation and viewing transformations of 2D and 3D line drawings. A chief goal of this Core work was machine and device independence to protect the software and hardware investments of users. Soon thereafter, the German Standardization Institute, DIN, began design of a Core graphics system that became GKS. Though similar to Core, GKS was to be a 2D system with less extensive functionality.

Both Core and GKS aim to allow a single application program to work with diverse input and output



The interface between the application program and the graphics utility program is crucial in a computer graphics system. *Core-based programs addressing this level have been commercially available for several years, but they are being superseded by ANSI X3H31 subcommittee standards, by GKS (graphical kernel system) and by PMIG (programmers' minimal interface to graphics). (IGES = initial graphics exchange system; VDI = virtual device interface; NAPLPS = North American presentation level protocol syntax.)*

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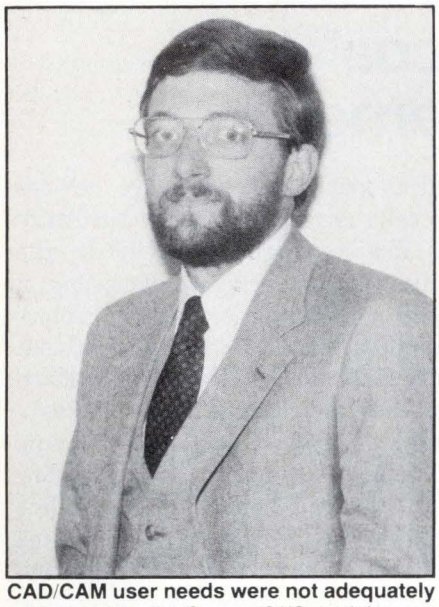
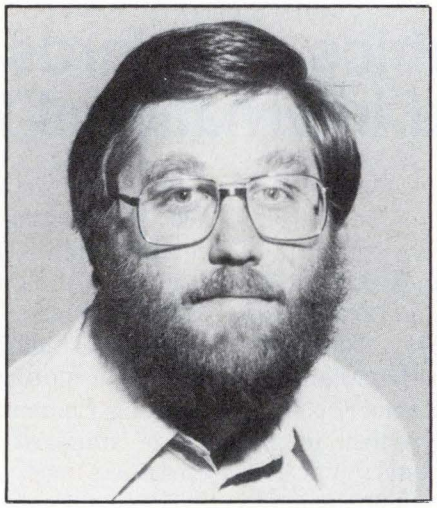


CAD/CAM user needs were not adequately addressed *by the Core or GKS models, says McAuto's David Shuey.*



"ANSI committee X3H31 was dissatisfied and took Core apart," says David Straayer, *Tektronix software development engineer. "And they are still rebuilding their rich standard. Meanwhile, GKS has whizzed past."*

"GKS is much better than Core," says ANSI X3H3 chairman Peter Bono. *"It's cleaner and has increased capabilities, including raster primitives that Core did not originally define and just tacked on as extensions."*

peripherals. To achieve this device independence, the application program calls Core/kernel routines (or functions), which in turn drive "virtual" graphics I/O devices. For each I/O device, a device-dependent routine called a device driver translates the "virtual" instructions into hardware instructions. Thus, to take advantage of a new I/O device, a user needs only a new device driver, not a rewritten application program.

In 1977, GSPC presented an initial design for the review of the graphics community, followed in 1979 by a revised Core system proposal based on that input, which incorporated extensions to accommodate the emerging field of raster graphics. Meanwhile, several iterations of GKS were being designed in Germany.

Commercial implementation of the Core system soon appeared. One of the first came from Boulder, Colo.-based Precision Visuals, Inc., founded by GSPC members James Warner, Nikolaus Kiefhaber and Margaret Polisher, who drew on their involvement in the design of Core methodology and on experience gained in implementing Core-based software tools at the University of Colorado. More than 20 commercial implementations are available today, including firmware versions from Ramtek Corp., Hewlett-Packard Co. and Aydin Controls. Even Tektronix, with a strong de facto standard in Plot-10, developed a Core-based set of graphics utilities called IGL.

Commercial activity was just gaining momentum in 1979 when the GSPC passed its standards proposal to newly formed ANSI X3H3, the formal standards body for graphics in the U.S. As Bob Heilman, director of software product management for Ramtek and former X3H3 committee member says, "Five years of work went down the drain."

David Straayer, software development engineer for Tektronix and another X3H3 committee member, explains that the Core standard was passed to subcommittee X3H31 in pretty good shape. "It resembled a mechanical part that had just come out of the prototype shop: a few burrs and imperfections," says Straayer. "But when X3H31 sat down to file off the rough edges, they got carried away. All we were left with were shavings on the floor."

The problem was caused by a lack of advocacy for the Core standard as it was, explains Peter Bono, ANSI X3H3 chairman and vice president of Pawcatuck, Conn.-based Athena Systems, Inc. Bono says a struggle existed between those who wanted to enrich Core's high-end capabilities and those who wanted to perfect a leaner standard. Heilman says that conflict, plus a lack of concerted effort resulting from the volunteer basis of ANSI committees, caused him to give up on ANSI and advocate bypassing the group.

"In retrospect, I see we made a naive decision not to forward our Core document to the International Standards Organization Level," he says. "When we didn't, the Germans sent GKS, which wasn't in nearly as good shape, and many of the best people in the American graphics standards efforts devoted their attention to ISO." (At the June ISO meeting in Eindhoven, the Netherlands, the specification of GKS was set, and U.S. representatives led by Bono agreed to

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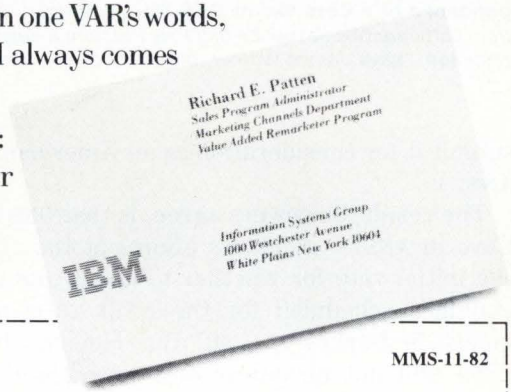

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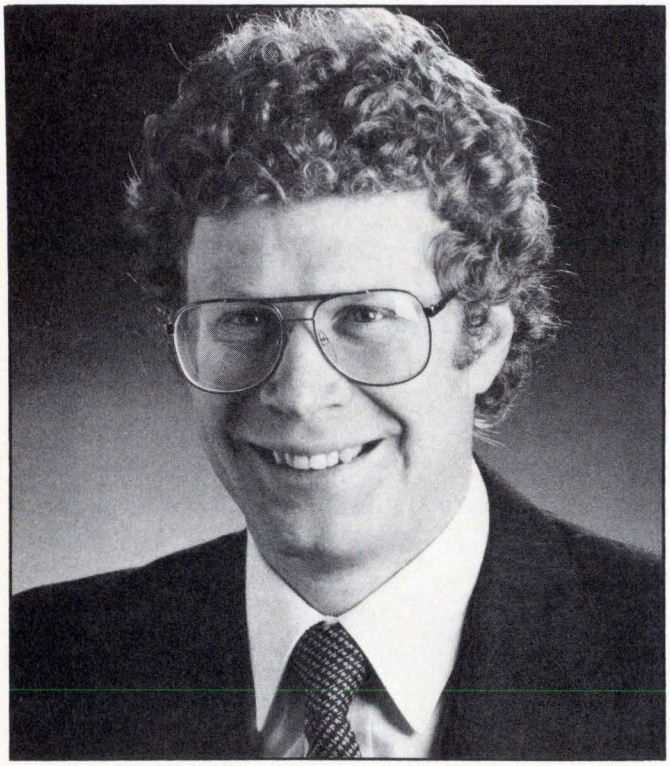


"Today's graphics buyers are demanding the application independence of a Core-like or GKS-like package, *and the protection from software obsolescence that they get from a device-independent package," says James Warner, president of Precision Visuals, Inc.*

submit it for consideration as an American standard by ANSI.)

The result, observers agree, is that GKS has replaced Core in ANSI's standards efforts at the 2D level, with the initial vote for whether to adopt GKS as a national standard scheduled for the ANSI X3H3 meeting this month in Berkeley, Calif. But Heilman believes that Core will not disappear any more than Plot-10 has. "American companies with Core-based systems will end up splitting their efforts," Heilman says, "which will increase training and maintenance costs. And it's sad that we've passed the baton to Europe. Our universities were teaching Core. Now, suddenly, they've got to catch up on this new thing."

But Bono argues that the need for international cooperation, given the scope of most computer companies' sales, would have caused Core to emerge from ISO in much the same shape as GKS. "For one thing, the Europeans would never have accepted the concept of current position," says Bono.

In Core-based systems, objects are defined by movement away from a reference point, or current position, that is analogous to the position of a pen in a plotter. Drawing a line from current position to a second point changes current position to the second point. Critics say the concept of current position becomes undefined when a coordinate system is transformed, and current position is uncertain after a graphic device draws a string of characters using the hardware character generator.

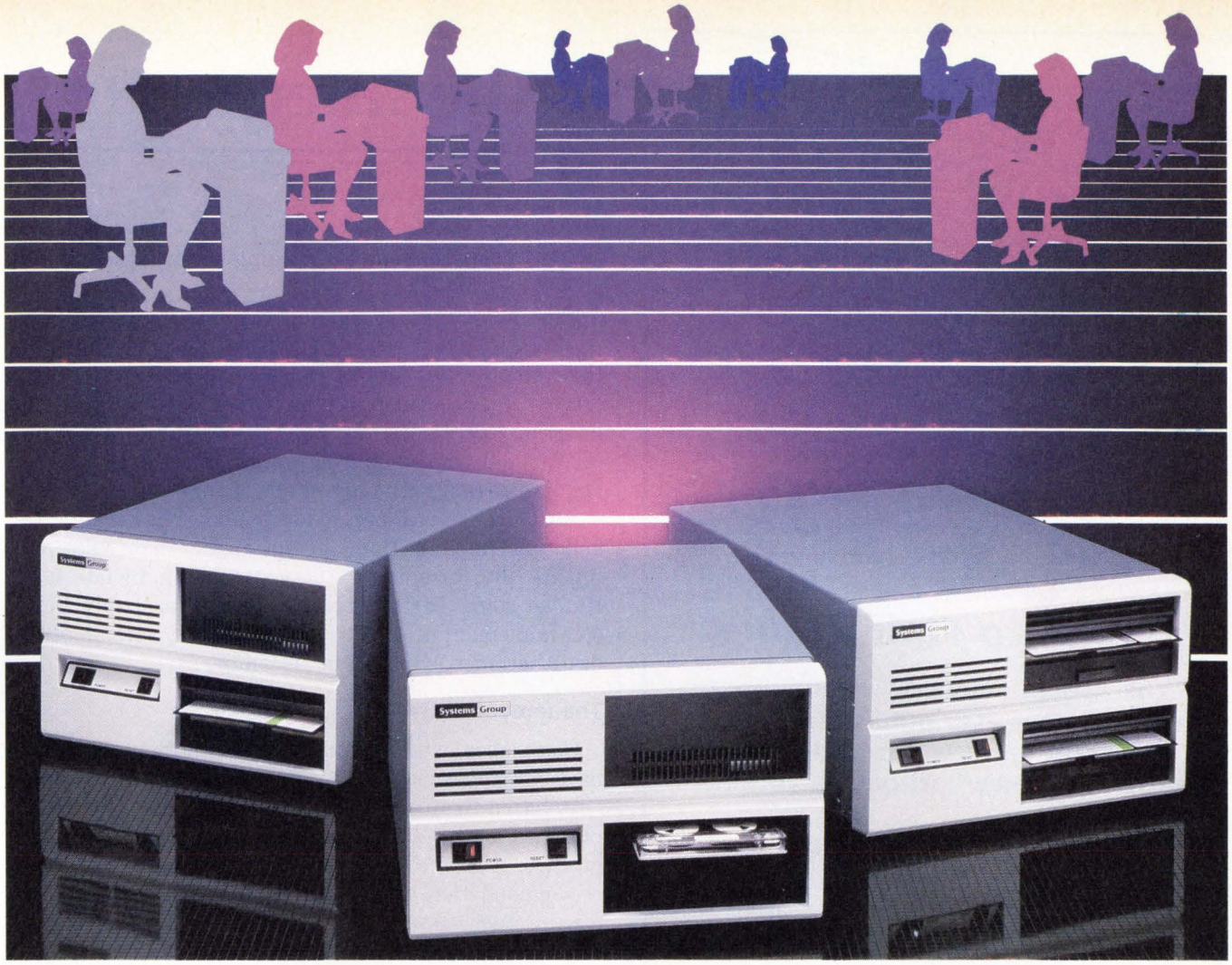
Just as Core advocates would have compromised by sacrificing the concept of current position, the Europeans in ISO compromised by incorporating 28 suggestions, the most significant of which concerned bundled and unbundled attributes.

"ANSI told ISO at the last meeting that we could not accept GKS's bundling of attributes," explains Tektronix's Straayer. In GKS, primitives such as lines could be differentiated by such attributes as color and thickness, but a programmer specified only that the differentiation be made. How to distinguish two values in a bar chart would be determined at the device level according to the bundles of attributes assigned to take best advantage of that device's capabilities—gray and black for a monochrome device, perhaps, colors for another. But this scheme enables a device to represent profit in red and loss in green, for example, leading to misinterpretation of the information because loss is normally represented by red. "ISO bent," says Straayer, "and the GKS standard as adopted allows the option of direct programmer control of attributes if desired."

Core translation/conversion

Bono, Warner and others agree that Core and GKS functionality correspond 80 to 90 percent, permitting a partial mapping of Core systems to GKS specifications. But Bono says a clean translation would require a "straightforward but extensive" rewrite that visited all of a Core package's subroutines. Karla Vecchiet, author of Hillsboro, Ore.-based Metheus Corp.'s Axia graphics package, a subset of Core functionality, goes further: "You wouldn't convert," she says. "You'd write a new package."

GKS proponents say it refines many of Core's concepts. Straayer, for example, says GKS has a better method of controlling multiple workstations. Bono says GKS goes beyond the functional description that defined Core and explores syntax. "We realize now that for a standard to be practical, it needs to be bound to a language," he says. He suggests that members of professional societies and users groups contact Mark Skall at the National Bureau of Standards, Washington, D.C., to offer feedback about language bindings. One question, Bono says, is whether the binding should be an official part of the standard or should be just an attachment. Other questions include whether a group



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outside ANSI should do the binding and what languages should be used.

"The advantage of binding is obvious," says Bono. "Currently, if you write a FORTRAN Core program and then change vendors to another set of Core-based FORTRAN subroutines, you have to do a rewrite of your program. But once an ANSI FORTRAN GKS binding occurs, you will be able to move applications between vendors of GKS with only minor changes."

Although several periods of public review and letter balloting remain, Bono is optimistic that ANSI will finalize GKS, including a FORTRAN binding, by late 1983. But he suggests that companies will probably begin GKS implementation as soon as a typeset version of the draft becomes available in December.

The impact of GKS

Companies with announced commitments to Core have already switched allegiance to GKS. Wilsonville, Ore.-based Graphic Software Systems, Inc., for example, has stopped marketing its GSS-CORE graphics utilities package, a 2D implementation of GSPC's recommendation. Vice president of marketing David Sharon says GSS-Core will be replaced with a GKS-based package called GSS-Kernel. GSS also announced a joint-development project with Digital Research, Inc., Pacific Grove, Calif., for GKS-based software. The project would put 20 graphics device-driver overlays into DR's CP/M operating system. And Tom Wright, director of development for Integrated Software Systems Corp., San Diego, says his company backs GKS by making the DISSPLA package of graphic routines comply with the proposed ISO specification. "Core will fade very quickly," Wright predicts. "Blessing by ANSI has enormous impact. Just one example: soon government contracts will specify GKS ANSI compliance."

But Bono, a strong GKS proponent, isn't sure Core will disappear. GKS simply doesn't provide enough functionality for all users, he says. Although ISO is committed to a 3D version of GKS, and ANSI subcommittee X3H31 is working on a 3D standard that is likely to be a rich superset of GKS, Bono suggests that users who need greater functionality should buy an existing Core package. "Later, when a rich standard is finalized, they can write a shell routine to map most of Core's functions onto that GKS superset," says Bono.

Precision Visuals' Warner says his company has more than 250 installations of its Core-based DI-3000 series of FORTRAN graphics subroutines, and has announced support for GKS. "We'll provide compatibility via sideways extensions," he says. "But we find that users are more concerned with the robustness of a software system, and the intelligence of its device drivers, than

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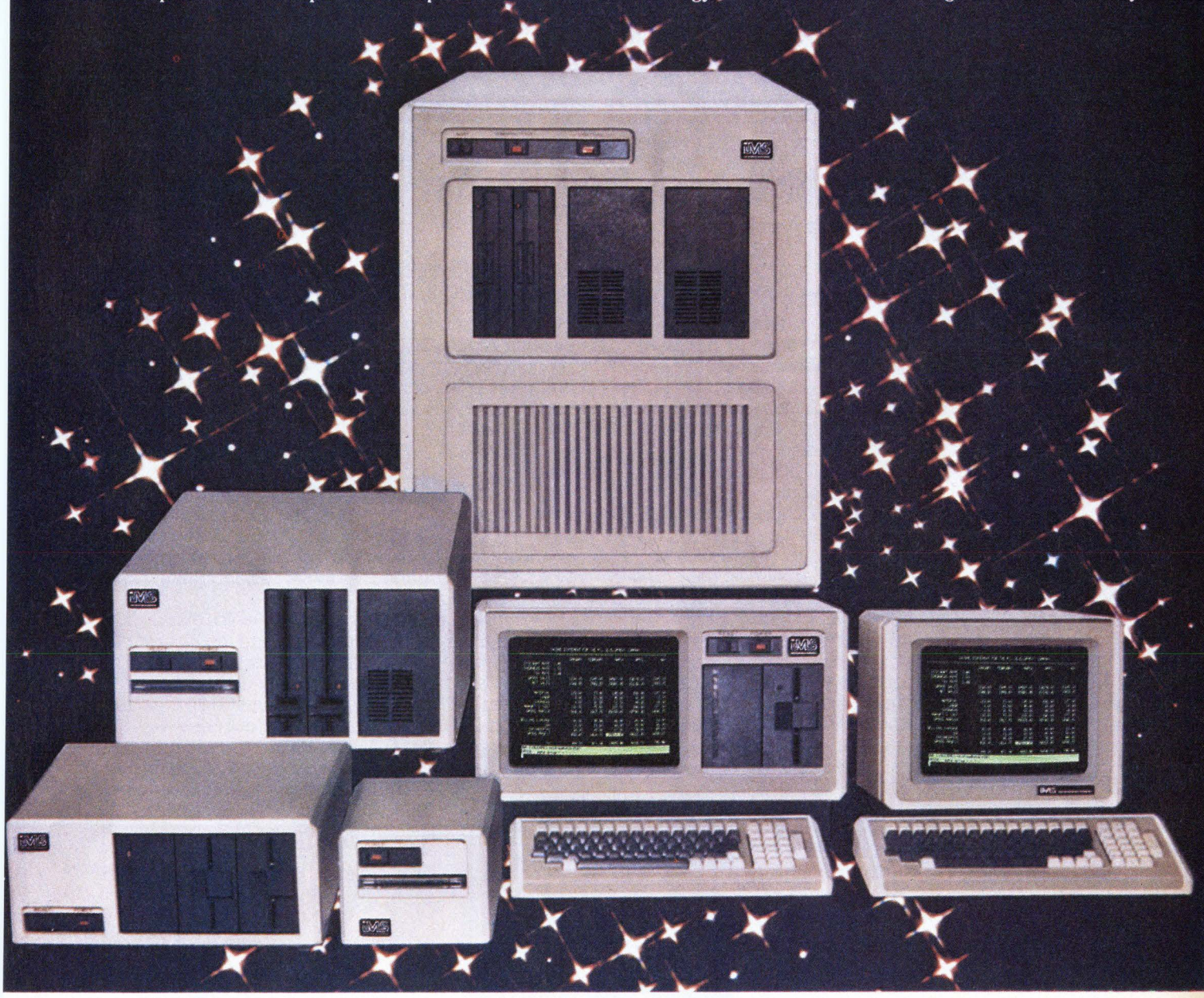

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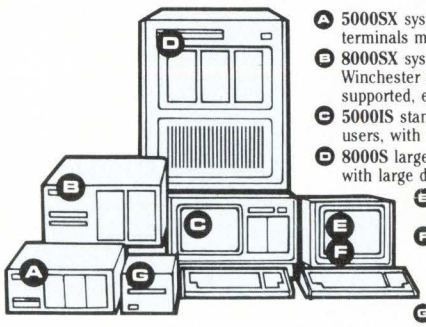

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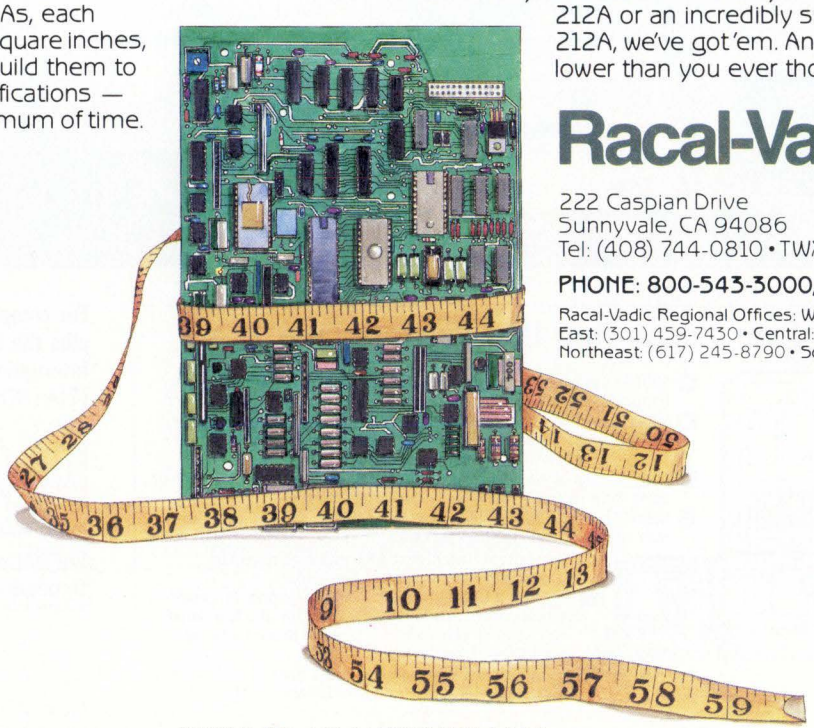

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with strict adherence to a particular graphics standard."

X3H31 and PMIG to flank GKS

The X3H31 subcommittee, which began with the Core proposal as the baseline for its efforts, is now studying additional capabilities that have been requested by more sophisticated user communities, primarily CAD/CAM system implementors whose needs are not met by GKS. Most observers see a need for GKS compatibility and expect X3H31's standard to be a GKS superset. But X3H31 chairman David Shuey, a software engineer for McDonnell Douglas Corp.'s McAuto division, St. Louis, says it is not clear whether that increased functionality will allow the compatibility with GKS that ANSI desires. Shuey's subcommittee is studying how to improve use of the local intelligence of display systems, how to improve the GKS display list-segmentation model (perhaps by making it hierarchical) and how 3D output primitives and viewing constructs might be added to GKS. Observers do not expect X3H31's "rich" system to reach the final draft stage until 1985 or later.

On the low end of GKS functionality, ANSI subcommittee X3H35 is considering the needs of another constituency in formulating its PMIG (programmers' minimal interface to graphics) proposal. PMIG is intended to serve users who need graphics on systems not dedicated to graphics applications, such as personal computers. "PMIG will consist of about 30 functions," says Tektronix's Straayer. "Even programmers who do more than just write graphics will be able to keep it in their heads."

PMIG chairman, ISSCO's Wright, says, "PMIG is pretty likely to be a subset of GKS," and he admits there are advantages. Previous adherence to the current-position concept in Core caused unnecessary overhead, he says; without it, the number of functions needed to implement PMIG is halved. Nevertheless, Wright says he feels disenfranchised by the superimposition of international efforts on the U.S. standards process. "I should have pushed my objections to certain Core features at the international level," says Wright, "because those objectionable features were incorporated into GKS, and now, the burden of compatibility falls on us."

Wright expects a formal draft specification of PMIG to be available for public comment by spring of 1983 if schedules are met.

PMIG will be defined using formal specifications to describe the semantics. FORTRAN and Ada language bindings are under way and should result in the appending of subroutines to the standard. Additionally, the ANSI committee working on a BASIC standard plans to bind to PMIG by adding statements to the language

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The Interpreter

that perform PMIG functions.

Below the three standards proposed for device-independent graphics software (PMIG, GKS, X3H31), lies the proposed interface to the device-dependent driver software, VDI (virtual device interface). Some graphics devices will eventually include a firmware shell that implements VDI, eliminating the need for the graphic utility software vendors to write software device drivers for new hardware.

VDI is forming into a lean and a rich set. The lean set, which addresses the standardization of current hardware functions, includes capabilities that must be in the terminal or simulated by software in the device driver. Capabilities in the rich set are optional functions, such as color or polygon fill, that the device "announces" to the interface. In this sense, VDI is driven from below by the devices. Yet it also must tie into the functions defined in the software layer above, points out Warner of Precision Visuals. Therefore, it must have the same flavor as GKS, PMIG and X3H31.

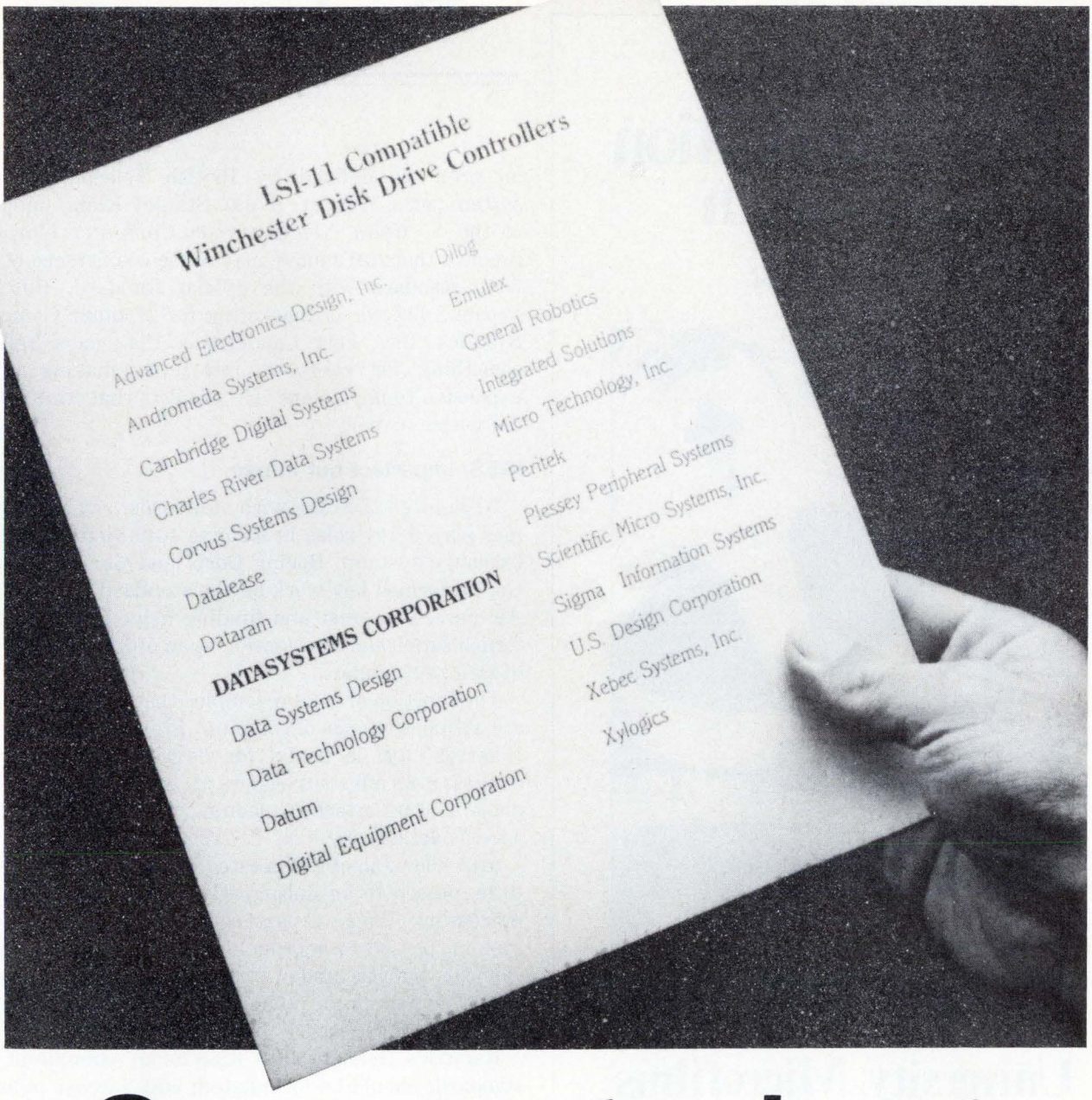
Led by Digital Equipment Corp., Intel Corp. and Tektronix, 15 companies have announced technical and personnel support for the VDI standardization process and will offer products based on the standard. Chairman of ANSI X3H33 VDI task group Ted Reed, of Los Alamos National Laboratory, expects a draft proposed standard on VDI to be available for public review in late 1983.

A related standard, VDM (virtual device metafile), will specify a data format for describing a picture in a device-independent form for translation and display on a variety of graphic devices. VDM, which will allow the transmission of computer-generated pictures between graphics devices and graphics software packages, should be out for public review by early 1983.

Also backed by the same 15 companies and being considered by ANSI's X3L2 committee on character sets and coding is NAPLPS (North American presentation level protocol syntax), often called PLP. It defines the interface and communication protocol for videotex devices.

Products based on the standard, as defined by AT&T in 1981, have already been implemented by Canadian firms Norpak Ltd. and AEL Microtel Ltd. Moreover, once the NAPLPS standard is finalized—public review will begin late this year—Intel plans to release a graphics controller chip dubbed the 82720 that will implement the standard at a cost two to four times less than TTL versions.

Despite this broad support, NAPLPS is not the clear winner in videotex. IBM Corp. spokesmen say the company is not committed to any standards, but it did recently announce the Series/1 Videotex System based



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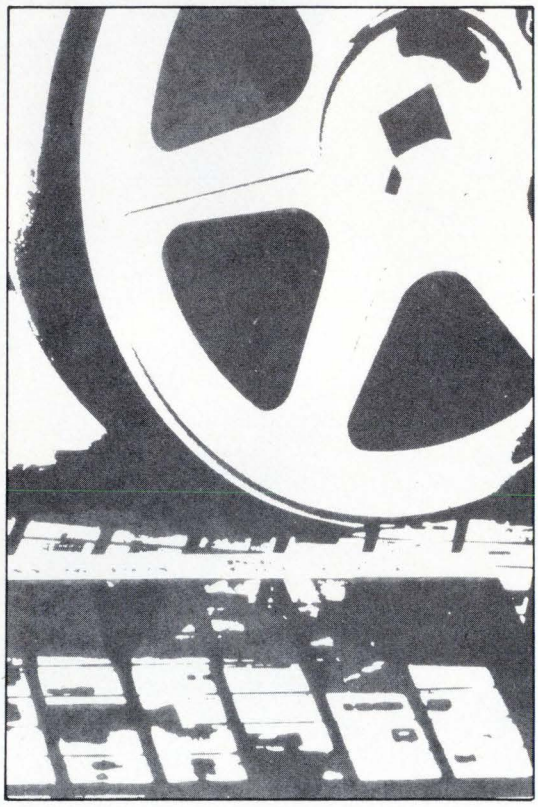

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on protocols defined by British Telecom's Prestel system (MMS, August, p. 83). Stanley Klein, publisher of the *S. Klein Newsletter on Computer Graphics*, predicts that IBM's move may cause coexistence of a de facto standard with the official standard. But Don Popalik, director of marketing for Modular Computer Systems, Inc., Fort Lauderdale, Fla., says Bell put something for everyone into PLP, making it too expensive to implement. He predicts that NAPLPS will fail within a year.

IGES: imperfect but in use

As is often the case with standards, several companies played key roles in forming IGES (initial graphics exchange system). Boeing Corp. and General Electric Co. performed key work on the standard, and the U.S. Air Force's interest and funding helped IGES through formalization and its adoption as an official Department of Defense standard.

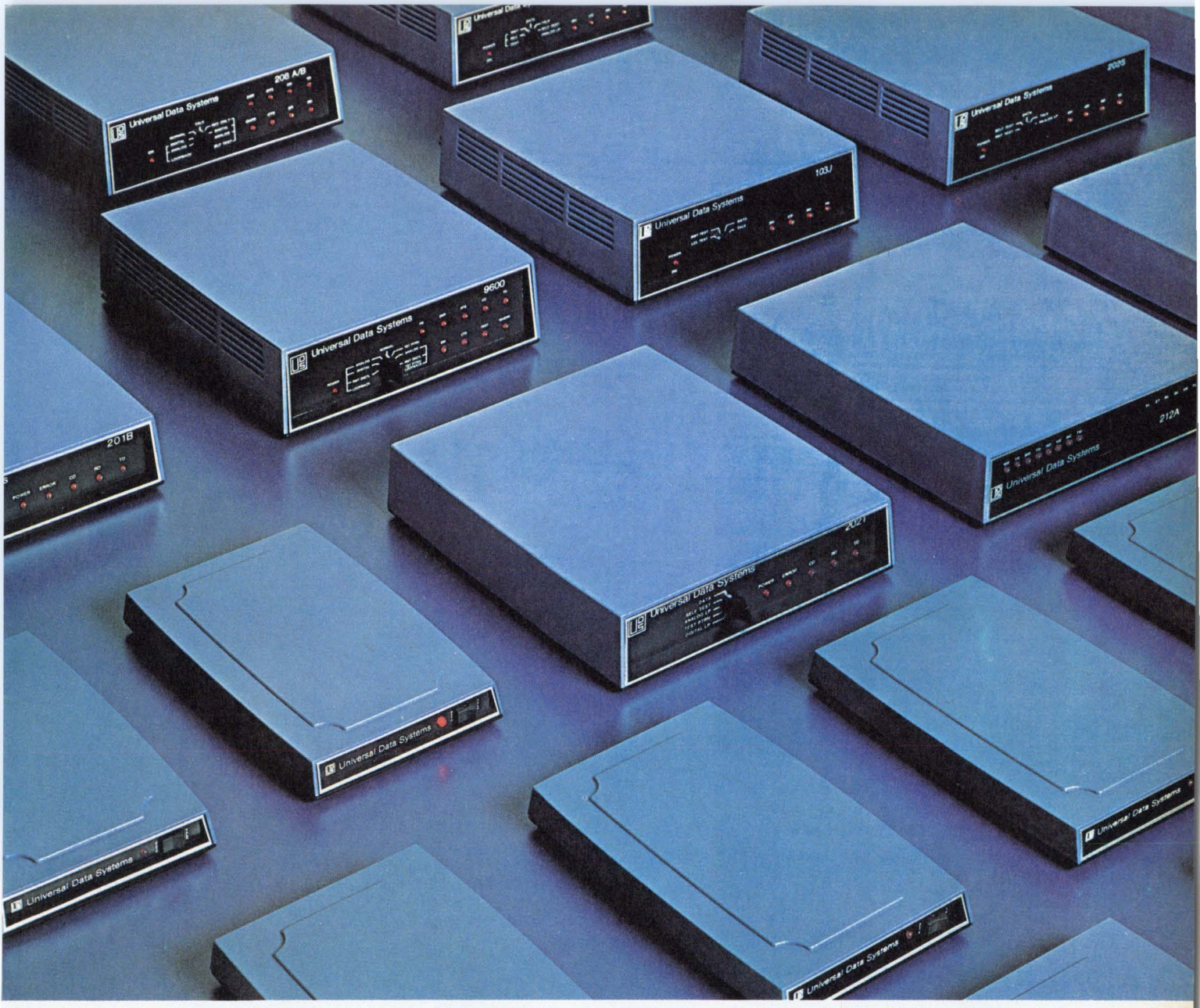
The function of IGES resembles that of VDM, but they are at opposite ends of computer graphics architecture. Whereas VDM is useful for device-level transfer of images, IGES effects transfers of CAD/CAM objects (both image and its attached meaning) between application-specific databases.

IGES allows an object created on one CAD/CAM system to be passed to an imcompatible CAD/CAM system for processing. Thus, a part could be designed on one system, passed to another vendor's system for finite-element analysis under stress and then passed to a third for creation of numerical-control tape to control machining of the part.

Ramtek's Heilman cites IGES as an example of how standards should be formulated: with intense industry participation and without perfectionism delaying implementation. IGES has been described as a baseline that will provide immediate and functional benefit while users gain the practical knowledge for more advanced efforts. Although ANSI formalized IGES as a standard only this year, such CAD/CAM heavyweights as Applicon, Inc., Computervision Corp., Calma Co., MCS and McAuto are already offering pre- and post-processors that transform objects represented in their proprietary database format into IGES-compatible form.

IGES is not perfect. "It has to be a least common denominator," explains Roy Salzman, president of Matra Datavision. "It can't deal with the full richness of every vendor's database format."

The dilemma faced by IGES implementors is the basic standards dilemma: one standard can't be everything to everybody, but it has to try. ANSI's IGES committee is back at the drawing board, trying to enrich its standard. □



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Facsimile emerging as key office-automation facility

By Dwight B. Davis
Associate Editor

Despite regular predictions over the years of the facsimile market's impending demise, the technology is still alive and kicking. In fact, facsimile—a method of scanning hard-copy pages, coding the text and graphic images into bit streams, communicating the data and reproducing the page at another location—has experienced a renaissance since the emergence in 1980 of international facsimile standards. Many companies active in the fax market believe the recent CCITT standards, along with bolstering the traditional point-to-point stand-alone market, will also play an important role in computer-based office automation. These companies, and some office-automation vendors such as Wang Laboratories, Inc., and Datapoint Corp., are promoting or promising integrated fax equipment, but few expect widespread facsimile integration to occur before the mid-1980s.

If facsimile's role in office automation still wallows in a mire of unrealized potential, part of the blame rests with vendors and customers who have yet to define clear objectives for "the office of the future." "The user is deluged with different technologies and systems from different vendors, and there seems to be some confusion on the part of the marketplace about what office automation really is," says Gary Winkler, director of product marketing at Rapicom, Inc., Fairfield, N.J. Most facsimile vendors are confident that their technology will figure importantly in automated offices, but some feel stymied in their development efforts because they have no mandate to follow.

"It's a dilemma for most manufacturers, including ourself," says Richard Lindenmuth, vice president and general manager of Burroughs Corp.'s Imaging Systems division. "The technology is there today, but we can do so many different things with it that for us to take a shotgun approach would be too expensive. If we were to take a pure rifle shot, the probability of hitting the bull's-eye would be pretty slim."

The Pitney Bowes 8800 digital facsimile unit *transmits pages at 20-sec. rates, is compatible with CCITT Groups I, II and III and features an activity journal of messages sent and received in a 24-hour period; security pass codes; and date, time and location identification on each transmitted message. Options include an automatic dialer that can store 50 telephone numbers and an RS232 interface for operation as a remote printer.*

Stand-alone fax market is strong

For a technology with very low market recognition, facsimile boasts surprisingly strong market-growth rates and penetration (see chart, p. 192). Yearly market-growth estimates range from 25 to 35 percent, and the installed base, as low as 18,000 units in 1970, now totals 250,000 to 300,000 machines. As much as 65 percent of these fax units may be older analog machines that take 4 to 6 min. to scan and transmit a page of data. Sold primarily by Xerox Corp., Burroughs, 3M Corp. and Exxon Office Systems Co., these U.S.-standard analog units are experiencing a negative growth rate.

Not so much replacing these older units as expanding the market with new users are higher speed analog and digital machines. CCITT Group II analog machines that scan and transmit a page in 1 to 3 min. are currently the largest selling units, says Ed Kash, manager of market planning at Canon, U.S.A., Inc., Lake Success, N.Y. He notes that the transmission volume requirements for

most applications are still best suited to Group II machines rather than to sub-minute Group III digital units, which are optimized in applications requiring transmission rates greater than 200 to 300 pages per month, he says.

While 6-min. machines are relatively inexpensive, Kash points out, "The criterion for buying a fax terminal should not be price; it should be the throughput cost per page." He says any company transmitting more than two pages per day or 44 pages per month pays more to the phone company in transmission costs than they save in the slow fax unit's rental or purchase price. This same costing criterion is now beginning to impact the higher end of the Group II market, as sub-minute digital machines continue to drop in price and become more competitive with top-of-the-line analog units (see graph, p. 197).

The standardization of the digital Group III facsimile presaged the first serious attempts to link the technology to computers. Within the past year, several facsimile vendors have announced RS232 port options on some of their machines. The RS232 interface essentially permits the fax unit to serve as a remote printer at locations that would typically install separate fax machines and printers. But this option is, by most accounts, not yet much in demand, and people who envision facsimile/computer integration look far beyond a simple serial interface.

From crisis message to document

Like telegrams, most facsimile messages sent between traditional stand-alone machines are crisis-type messages, not documents. As such, the fax messages require no archival storage or manipulation. This transitory nature of fax transmission is fortunate, because the problems of storing and manipulating fax data are far from trivial. But these barriers must be overcome if facsimile is to play an important role in the document-driven environment of the office.

Two major drawbacks exist in transmitting fax data into a computer's database. First, the bit-stream fax protocol is totally different from standard data-communications protocols. Fax bit streams can be stored directly on disk, but, as such, the computer cannot manipulate the information. And the disk space required by even a single fax-encoded page is formidable.

"In their current state, facsimile machines make a rather severe demand on storage media," explains

FAX COMPANIES PLAN FOR FUTURE

Most vendors active in the traditional point-to-point facsimile market expect the stand-alone portion of their business to remain strong for several years. However, many also plan to participate in the evolution as fax becomes integrated in automated offices. Several vendors' market plans and impressions follow.

- "The Group IV is the gateway to the office of the future. We're going very modular, and will try to have as few single-function devices in an office as we can. We're trying to integrate everything."—Richard Lindenmuth, vice president and general manager of the Imaging Systems division, Burroughs Corp.
- "While many CRT terminals, engineeringly, can be modified to function as automatic message-switching terminals, less than 5 percent of them are. CRT and facsimile technologies are not hostile to each other; they overlap. The reason is, with fax, you send as is."—Ed Kash, manager of market planning, Canon U.S.A., Inc.
- "Over the next year or two, the facsimile industry will have to progress to (the integrated) dimension. Fax vendors will be moving into the office-automation market if they can. If not, they're going to have to bail out."—Ron Butindari, Northeast district manager, NEC America, Inc.
- "Group II and III standards had a big positive effect on the facsimile market. Before Group III, everyone wanted to keep private because they all thought they had something better than anybody else. In the end, all the proprietary devices turned out to be very similar."—Ken McConnell, technical operations director, Panafax Corp.
- "We think facsimile is a logical fit with our existing mail-processing business, which has a worldwide customer base of about 2 million. While we don't see a dramatic substitution of physical mail by electronic mail, we look at our entry in the fax market as an opportunity to provide a capability that a lot of our customers already have or are interested in acquiring."—George Gelfer, director of worldwide marketing for facsimile, Pitney Bowes Inc.
- "We feel there will always be a need for point-to-point, stand-alone facsimile. However, the great growth area for fax will be at the other end of the spectrum—the system-oriented, office-automation market, where fax will be integrated with other office technologies."—Gary Winkler, director of product marketing, Rapicom, Inc.
- "You will never see us build another point-to-point facsimile terminal. We're moving very heavily toward integration, but we don't want to go head-on-head against a data-processing environment. We want to help executives communicate."—Tom McGlynn, product marketing manager, facsimile, 3M Corp.
- Integrating facsimile means more than interfacing on CCITT standards. I can put an RS232 or TTY on two bricks and they'll communicate. Right now, we're the only information-processing company that has facsimile products in the marketplace with an installed base and working, traditional fax networks."—Al Martins, vice president of facsimile, Xerox Corp.

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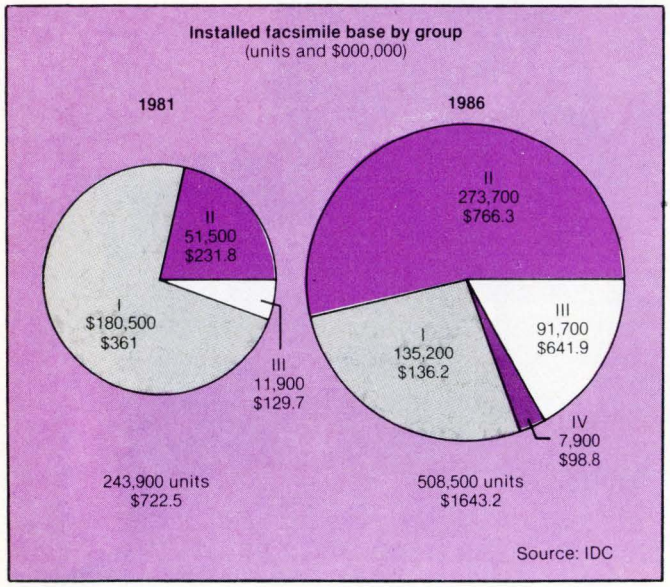


The facsimile base will double by 1986. *From 1981 to 1986, the largest market share of the installed facsimile base will shift from 4- to 6-min. Group I analog machines to 1- to 3-min. Group II analog devices, according to figures from the International Data Corp. report "Office Automation Equipment Markets, 1982." The strong Group II growth will begin to taper off in 1985 or 1986, the report says, as sub-minute Group III and Group IV (scheduled for 1984 introduction) digital fax units begin to exert more influence.*

George Gelfer, director of worldwide marketing for facsimile at Pitney Bowes, Stamford, Conn. "For an average digital page of fax, you're talking about 300,000 bits of data," he says. These data have already been compressed by the Group III standard encoding methods, Modified Huffman or Modified Read. And if the bit stream should be converted to a standard ACSII format—a function no one yet offers—the storage requirements would increase as a result of the overhead involved in the conversion.

One possible solution to both the protocol and the storage dilemmas is suggested by Lindenmuth at Burroughs, who notes that approximately 80 percent of facsimile messages consists of text. Lindenmuth says an intelligent scanner that combines an OCR-type function with the standard raster scanning of facsimile could permit the capture of most fax data in an ASCII format. "If the scanner doesn't recognize something, it shifts into facsimile mode," he says. "You just capture it as an image and then move on to the next character or line." The ASCII data could be economically stored and easily manipulated. "It really doesn't matter that some of your information is in facsimile protocol," Lindenmuth explains, "because all you want to be able to do with that data is show it or recapture it."

Even without capturing data in ASCII format, advances in other areas should alleviate the fax-to-computer problem, says Bob Ness, Datapoint's director of facsimile graphic development, Office Graphics Systems. "Many companies will evolve more efficient compression algorithms to minimize data storage," Ness says. "Disk technology will also improve, especially in the area of optical disk storage. In fact, optical disks will be driven as a technology by graphic images and the disk space they require."

Cautious steps into the office

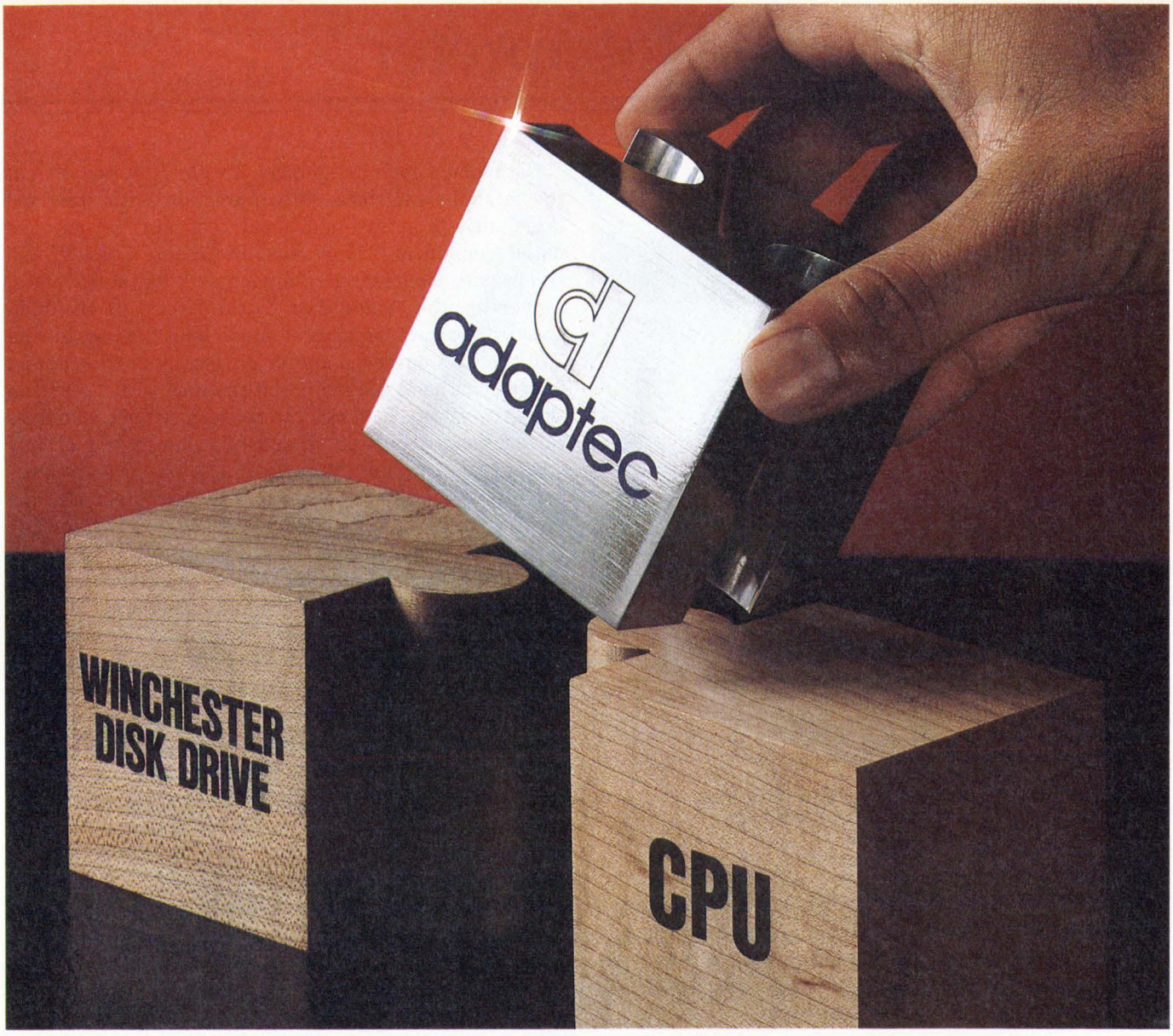
While almost every company involved with selling facsimile plans to sell integrated as well as stand-alone fax (see "Fax companies plan for the future," p. 00), two of the most advanced facsimile offerings come from office-automation/information-processing vendors Wang, Lowell, Mass., and Datapoint, San Antonio, Texas. Last year, Wang introduced its Image Transfer System, a $15,500 fax-type unit, and Datapoint announced plans to provide its 9498 facsimile communications interface, a "black box" compatible with all CCITT standard machines (MMS, January, p. 42).

Wang prefers to avoid the term "facsimile" in describing its Image Transfer System, reflecting the company's belief that the ITS represents an evolution beyond traditional fax technology. "I think the technology will lose its generic name of facsimile and will move into the category of true image processing as it becomes more integrated," explains Joe Sapienza, director of peripheral products at Wang. Nevertheless, he admits, "In function, we are equivalent to the existing Group III digital machines."

"Equivalent" doesn't translate into "compatible" in the case of Wang's ITS, however. The company has chosen, at least for the moment, to forge its way in the evolving market using a proprietary protocol. Sapienza leaves the door open for Wang to offer CCITT compatibility, noting, "I see steps being taken in the future to gain compatibility in some areas." He points to the proprietary options offered by most traditional facsimile vendors and predicts, "You will also find a mix of proprietary and international standards with integrated office facsimile."

Many question the propriety of Wang's proprietary ITS, however, saying the company has erred in ignoring the existing standards. Steve Shnipper, manager of product line marketing for Office Graphics Systems at Datapoint, says, "To do anything with Wang's Image Transfer System, you need to buy at least two units. An ITS is integrated with nothing. It only talks to another ITS." Shnipper admits the ITS is integrated in the sense that it can store document images on disk for routing within a Wang network, but criticizes the fact that the ITS can't communicate with the installed base of CCITT and U.S. standard machines.

"The advantage that our facsimile interface has is that it does not require a user to buy a unique device,"



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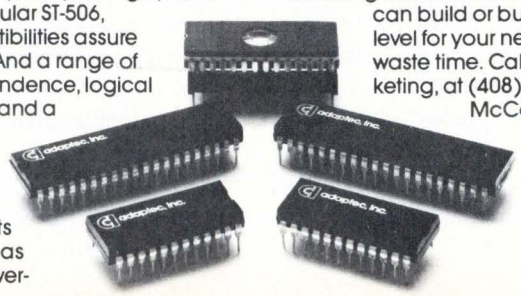

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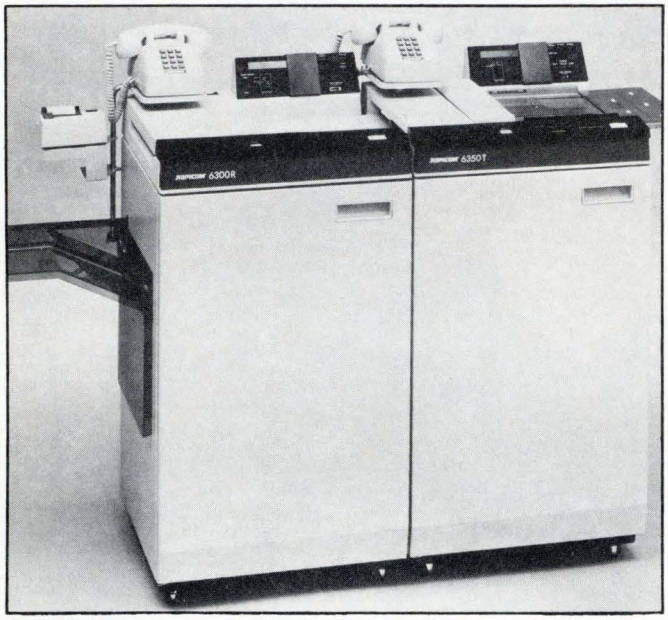

The Rapicom Group III 6350T/6300R facsimile unit *is capable of simultaneous transmission and reception of documents; operates at 9600 bps with fallback to 7200, 4800 or 2400 bps; can poll remote fax terminals for unattended message pick-up; and reproduces copy using an electrostatic, dry-toner printer. Options include Group II compatibility and Modified Read coding, which is approximately 10 percent more efficient than Modified Huffman coding.*

he says. "With the interface's capability to talk to any industry-compatible device, the user can broadcast an image virtually anywhere in the world." Datapoint's Ness adds, "Our intention is to provide the customer who is already utilizing facsimile with a means of enhancing and optimizing his existing network, without having to replace his current devices."

Much talk, little action

Regardless of which company's strategy proves best, Wang's and Datapoint's facsimile projections have a long way to travel before being fully realized. Datapoint's Facsimile Communications Interface is still in the firm's labs, with beta-site installations planned for January and full production scheduled for March or April. And at Wang, while some ITS units have been installed, the units are functioning much like traditional facsimile machines, sending and receiving transient data, with some of the control of data flow handled at the terminal level rather than directly at the ITS unit.

"We've just taken the first step in integration," Sapienza says, "and that integration is not 100-percent complete. As the technology matures, you'll find the true facsimile portion of it becomes only a part of the total program. It will become a means of not only capturing and transmitting data, but of capturing, manipulating and using wide varieties of routing facilities to better use the information that was captured."

Datapoint's goals are similar, but the first iteration of the facsimile interface—in conjunction with standard fax units—promises additional features beyond the initial version of Wang's ITS. Datapoint's device will accept data from standard analog and digital fax units, converting the analog data to the Group III Huffman encoded format, for placement on disk files within its Attached Resource Computer environment. Stored fax images can be displayed on bit-mapped screens within the ARC system, although the non-character-coded data cannot be manipulated. Images can be output on any standard fax machine or on an ARC-based 9660 laser printer. While the Datapoint product can't convert fax bit streams into ASCII-coded formats, users will be able to take ASCII-encoded files and convert them to bit-encoded graphic images, which can then be transmitted to and printed on facsimile machines.

As facsimile becomes more integrated in automated offices, the technology will probably follow the same route as that traversed by word processing—changing from an independent stand-alone configuration to a facility merged with several other operations within an overall system. In its new visage, facsimile may appear substantially different from its existing form. For instance, the output device on stand-alone facsimile units—typically a thermal or electrostatic printer—will be redundant, and probably eliminated, in a networked environment that already includes high-quality printers that can be shared. And if an intelligent scanning head performs most of the data capture using an OCR-type technique, the true facsimile portion of the operation will be considerably diminished.

Pushing fax beyond the standards

In the meantime, the traditional facsimile vendors are increasing their machines' functionality in ways that will probably prove popular in integrated fax. In an industry so dependent upon adherence to basic operational standards, additional features are the main way for the players to separate their products from the rest of the field. One capability many vendors exploit is the use of proprietary "skip" protocols that allow analog units to transmit at high speeds to other units employing the proprietary code.

Pitney Bowes is pushing the ability of its 8400 Group I and II analog unit to use its "network block skip" to operate at 35-sec. transmission speeds with other 8400s and with the firm's two digital units, the 8600 and the 8800. "One of the classical problems is if a customer has had a machine with a skip capability, it would work only with another skip machine, not with a Group III machine," says Gelfer. Fax units from Pitney Bowes or from other companies offering proprietary block or "white" skip modes automatically shift to CCITT stan-

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OPTIONAL OPERATING SYSTEMS (Supported by Company)[2]			
MS-DOS (PC-DOS)	Yes	Yes	?
CP/M 86	Yes	Yes	?
MP/M 86	Yes	—	?
OASIS-16	Yes	—	?
XENIX	Soon	—	?
OPTIONAL HARDWARE EXPANSION BOARD (Supported by Company)			
RS-232 Communications	Yes	Yes	?
B/W and Color Display Controller	Yes	Yes	?
Expansion Memory	Yes	Yes	?
Z-80 CP/M-80 Board	Yes	—	?
Cache Buffer Hard Disk	Yes	—	?
Time/Calendar Board	Yes	—	?
IEEE Bus Controller	Yes	—	?
8" Floppy Disk System	Yes	—	?
8" Hard Disk System	Up to 40 Mbytes	—	?
Tape Cartridge System	Yes	—	?

[1]For comparison purposes, typical professional configurations consist of 16-Bit 8088 Processor, 128K RAM with Parity, Dual 320K 5-inch Floppies, DMA and Interrupt Controller, Dual RS-232 Serial Ports, Centronics Parallel Port and Dumb Computer Terminal or Equivalent.

[2]Columbia Data Products also supports CP/M 80* with an optionally available Z-80 CP/M Expansion Board.

*As advertised in BYTE Magazine, August 1982.

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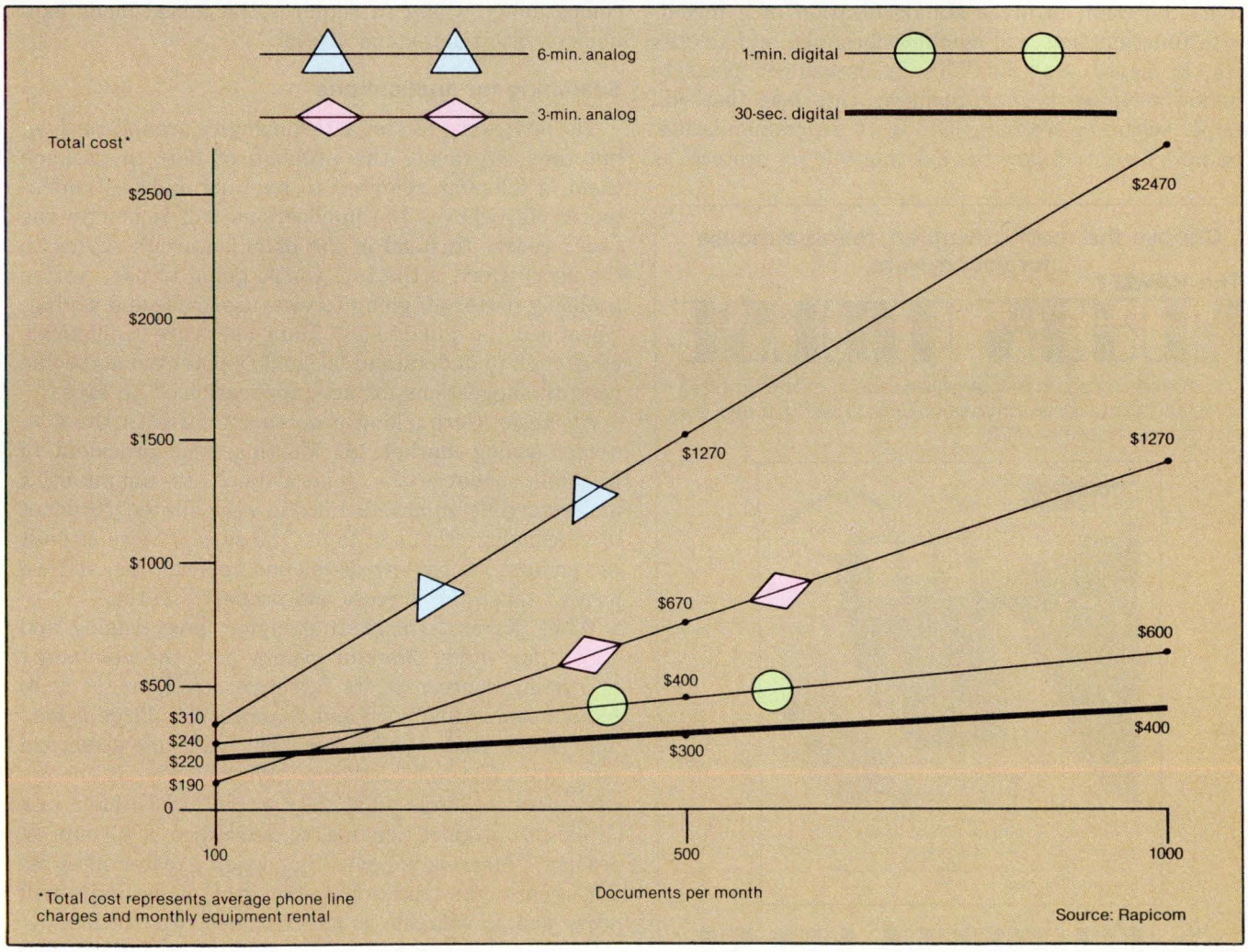
dard operation when communicating with a non-skip terminal.

Other enhancements provide optional scan resolutions beyond those specified by the CCITT standards, and raise the quality of the output devices while holding or lowering their costs. Various administrative features are also appearing on new machines. Such features as usage reports, automatic dialing across a list of stored numbers, polling of remote units by a central machine and placement of data on transmitted pages indicating the date, time and source of the transmission are becoming more common. In an integrated environment, the host processors could perform many of these functions, but some may remain in the fax-type unit to reduce the burden on the host.

All the companies planning integrated facsimile are working in the shadow of the CCITT's next set of fax standards, Group IV, scheduled for completion in 1984. By specifying 4-sec. digital transmissions and a host of other advanced capabilities, Group IV will, in the opinion of many observers, truly open the gates for facsimile's entrance to integration. Others believe the high costs likely to be associated with the Group IV technology will severely limit its impact.

Company strategies for handling the not-yet-standardized Group IV vary considerably. Rapicom, which had to retrofit its early digital units for compatibility with Group III standards is more cautious this time around, says Winkler. Despite Rapicom's success in winning and maintaining a large share of the digital fax market with its early entry, Winkler says, "If people rush out there and introduce what they think is a Group IV function and the standards are not approved to meet that technology, then there will be problems."



The total cost of facsimile. *Companies transmitting more than 100 documents per month between traditional facsimile devices can quickly cost-justify the use of 1-min. or 30-sec. digital machines, according to this graph from Rapicom, Inc. At a 100-document-per-month level, the low-cost, 6-min. analog machines are most expensive because of the higher line charges they generate. While still inexpensive at this level, the 3-min. analog machines soon surpass the digital units in total cost as the document volume increases. (The graph sets the monthly rental costs of the 6- and 3-min. analog units at $70 and the 1-min. and 30-sec. digital units at $200; long-distance line costs are set at 40¢ per min.)*

Others, such as Ron Butindari, Northeast district manager for NEC America, Inc., Melville, N.Y., believe companies should introduce advanced features and then adapt their units, if necessary, to meet the Group IV specs. NEC's high-end System III-C is a Group II/III machine with copier capabilities, 400- × 400-line-per-in. resolution and a multiport X.25 option. "I'm sure the Group IV standards will vary from our III-C to some degree," Butindari says, "but the machine is modular and designed to be converted easily."

While opinion varies about how the final Group IV specifications will appear, Ken McConnell, technical operations director at Panafax says, progress made at a CCITT meeting held in June leads him to believe "the IV standard may not be as far off as it had been." McConnell, a member of the EIA TR-29 committee that works with the CCITT, says several Group IV directions are clear.

One direction involves standardization of a mixed-mode function that will combine facsimile and teletex data, he says. AT&T has already announced plans to provide a Network Data Bridging Interface that will comply with the evolving Group IV recommendation. The interface, to follow the existing teletex protocol as defined by CCITT recommendations S62 and S70, will also support all mandatory parameters of the Group IV facsimile protocol and will operate at transmission speeds of 4.8K bps half duplex and 56K bps full duplex.

The high-speed transmission of Group IV will require access to a digital network. McConnell says the CCITT is working on techniques at the transport level of the networking hierarchy to permit data conversion between the three major network types—public-switched telephone network, circuit-switched data network and packet-switched data network. If CCITT is successful, he says, "Lots of devices will be able to talk to each other that normally can't communicate."

In scanning resolution, the CCITT apparently will go with three classes of devices, McConnell reports. "Class I will work at 200 × 200 lines per in. and will be compatible with Group III, with higher resolutions optional. Class II must have 300 lpi, with 200-lpi compatibility. Class III requires the mixed-mode capability, with teletex and 400 lpi."

Searching for applications

The advancing facsimile technologies are impressive, but they aggravate the problem of how to package them, a dilemma referred to by Burroughs's Lindenmuth. He believes the applications ball is now in the user's court. "Instead of the manufacturer's saying to the user, 'Here is the tool you're going to use,' you're probably better off going to your user base and saying, 'What is it you'd like to do?' Many users are sophisticated enough to understand facsimile's potential and come up with suggestions for new applications," he says.

At Xerox Corp., long a dominant force in the U.S. 6-min. analog market, Al Martins, vice president of facsimile, believes the general business community's understanding of facsimile is still very limited. "It's not the technology that's at fault," he says. "We're at fault as vendors. We haven't developed applications, and we haven't taken the process and properly sold it."

While Xerox is marketing higher level analog and digital fax units, Martins points out, the company's overriding concern in its facsimile development is to remain compatible with and to protect its large 6-min. unit base. And, while the firm will move toward integrated facsimile, he says, "We haven't got enough customers to define what they would like to have in a Group IV product for me to announce a Group IV product." Martins believes that when greater integration occurs, the traditional strengths of facsimile will prove just as valuable as its expanded capabilities.

"Every other technology is delivering information that has to be managed, handled, recreated, digested and reformatted," he says. "Facsimile seems to be the only business that's delivering the end result." □

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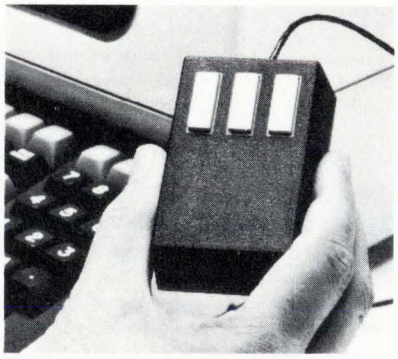

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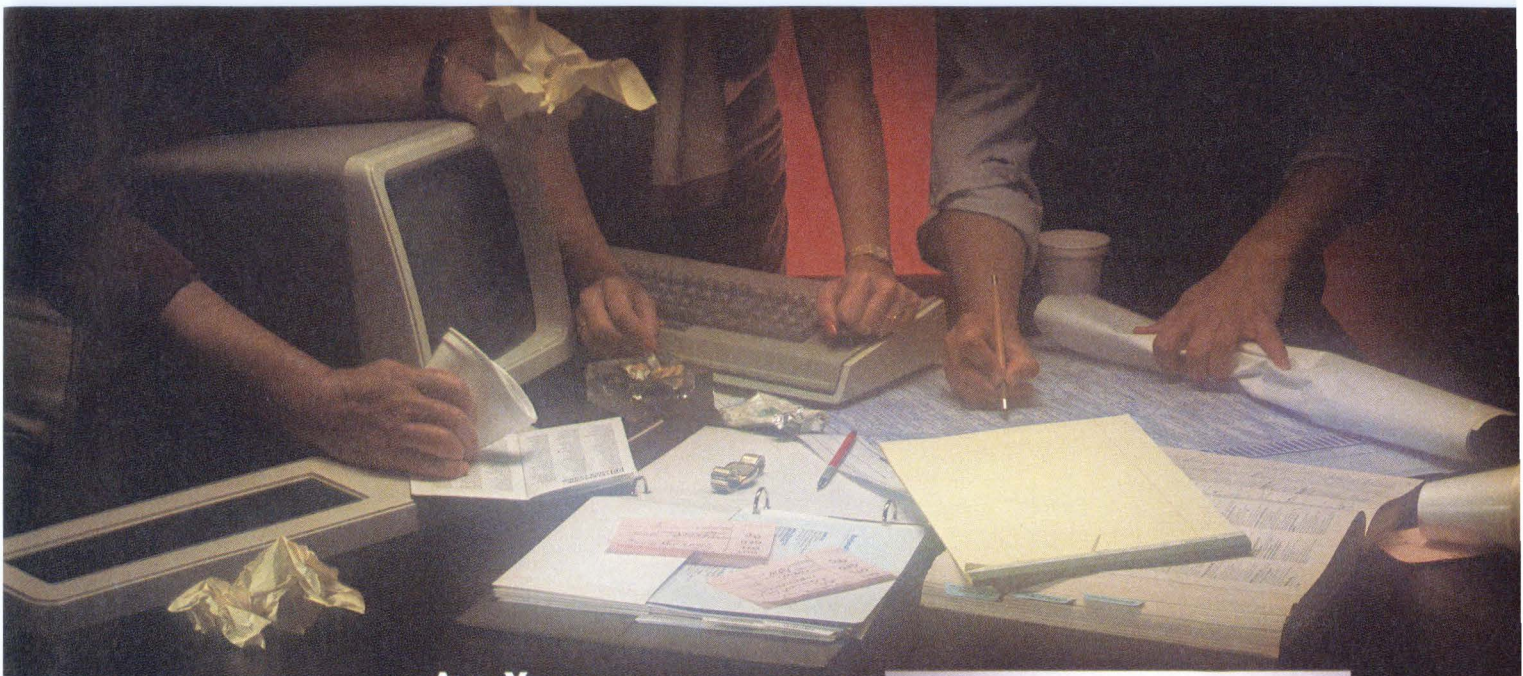

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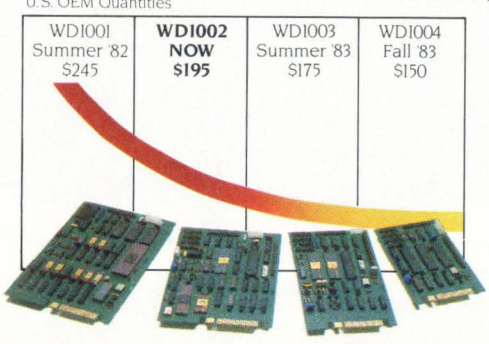

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Robotic vision systems eye factory applications

By Eric Lundquist
Associate Editor

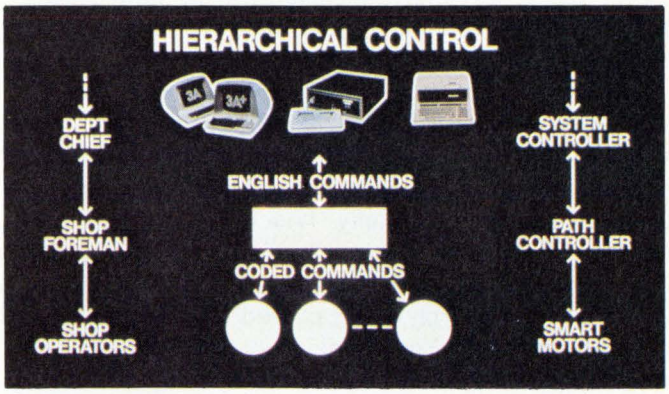
Artificial vision inspection and control systems, which were technologically and economically confined to the laboratory, are eyeing a place on the manufacturing floor. That's not to say all the technical obstacles have been overcome and, at $29.4 million in 1981, the vision-systems market is small, but the underpinnings of the vision business appear sufficiently strong to warrant attention from manufacturing-system developers, system purchasers and investors.

Vision acts as a peripheral data-input device to computer-based manufacturing systems ranging from stand-alone inspection stations to sight-guided robot workstations. Vision systems capture an image using a solid-state camera, transform the image into a digital representation and, depending on sophistication and power, manipulate the information to guide machinery or perform quality control and inspection. Applications include assembly, inspection and noncontact measurement. Although vision got its start in the automotive market, it is finding a home in electronics manufacturing. The systems can range in price from less than $20,000 to several hundred thousand dollars for specialized applications.

"Driving the vision market are two forces we hear discussed over and over again in American industry: higher productivity and improved product quality," says James A. Kimberlin, an analyst at Insight Associates, Carson City, Nev. "Vision systems offer payback periods as short as three months and performance unmarred by fatigue and boredom, and excel in tedious, labor-intensive work."

An additional force driving the market is one familiar to all system builders. The same powerful microprocessors such as the Motorola MC68000 that are powering business systems are turning up in vision systems to handle the computations required to make vision a real-time process. Also appearing are entrepreneurs who are as familiar with microprocessors as they are with the factory floor. In 1969, then 24-year-old Dwight D. Carlson founded a company later called Xycom that sells "hard-hat" microcomputers and marketed a box-level product built around the Intel 8080 before Intel Corp. announced the product. In 1981, Carlson decided vision technology would be as significant a new technology as the microprocessor, and he is now president of Perceptron, Farmington Hills, Mich., a $2-million start-up using the Digital Equipment Corp. LSI 11/23 but considering switching to the MC68000. Kimberlin says the noncaptive installed base of manufactured vision systems grew by 83 percent in 1981 to 1031 units from a 1980 total of 562 units. Shipment value rose to an estimated $29.4 million in 1981 and will top $1 billion in 1991. Kimberlin also notes that the number of vision companies has grown from a handful a few years ago to more than 66 firms. Venture capitalists and investors have also shown a willingness to invest in new companies, and more than $40 million has been poured into eight start-ups that make robotic vision systems. Robotic vision systems constitute just one of seven vision categories that Kimberlin defines. Much of that investment capital appears destined for R&D in several areas that pose problems for vision developers,

Control Automation uses a modular technique *in which the components of the vision system are physically separate.*



Control Automation's vision system *uses a hierarchial control and English-like commands, an HP85 as system controller and an Intel 8086 as vision processor.*

including most vision systems' inability to discern overlapping parts, the need to develop bin-picking capabilities and the need to eliminate special lighting.

In addition to the technical problems of vision, system developers must also wrestle with the problems of networking, hierarchial control, user friendliness and hardened systems that are common to all manufacturing system developers.

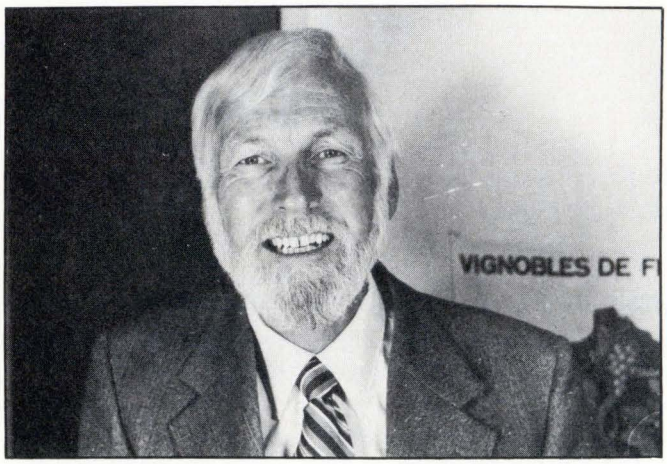
Despite the drawbacks, vision systems are finding an increasing market. They are being used in such applications as:

- Quality control. One supplier of automatic clutch assemblies to General Motors Corp. uses a Prothon vision system to assure the parts meet the GM specs.
- Parts sorting. A manufacturer of phonograph-cartridge styli uses an Ocktek Inc. vision system to sort by length diamonds too small for jewelry. The diamonds are then ground to a specified diameter. Six human workers can inspect as many diamonds in a day as the vision systems complete in about two hours.
- PC-board assembly. Vision systems help assure that the proper components are inserted and oriented in a board.

Vision systems are finding a ready market because companies now recognize that quality control and manufacturing competence are as important to fiscal well-being as are technological prowess and financial acumen. This is especially true in the electronics industry in which a tremendous amount of value is added at each manufacturing process, and undetected errors early in the process can lead to costly trouble-shooting later. As a result, vision-systems manufacturers are vigorously pursuing the electronics market.

"Our direction is in the electronic and computer side of the industry," says Michael McCraley, director of marketing for Control Automation. The Princeton, N.J., start-up has taken a modular approach to both robotics and vision systems. The direction of vision away from automotive and toward electronics applications is supported by Insight's Kimberlin: "Automotive in the past has taken a lot of vision systems, but the lead is moving over to electronics, and eventually, the electronics industry will be the leading user of vision systems." Control Automation's approach physically separates the components of the system and links them over an RS232 line. This allows the vision system to be tied into other host computers "as long as they deal in ASCII strings," McCraley says.

McCraley divides vision systems into three technological areas: character recognition, pattern matching and profile recognition. A character-recognition system looks at characters or symbols and requires a rigid presentation of parts. In pattern matching, the pattern



James A. Kimberlin of Insight Associates: *"Driving the vision market are two forces we hear discussed over and over in American industry: higher productivity and improved product quality."*

of an ideal object is compared with the actual object. A profile-recognition system looks at features and identifies an object based on recognition of those features.

Newell V. Starks Jr., president of Everett/Charles Automation Modules Inc., told a gathering at the 1981 Autofact III show, "Basically, machine vision is the technique of equipping a computer with an eye so that the computer can receive visual inputs the same way it receives inputs from a keyboard, a magnetic disk, a tape or any other recognized method of data entry. By equipping a computer or data-processing system with this eye, we are taking the first step toward automating visual inspection, which has been described as the least automated aspect of modern manufacturing.

The basic components of a vision system often include a 16-mm. vidicon camera that captures a black-and-white image of an object. That image is transmitted to a processor that superimposes a horizontal and vertical line grid over the image, which divides the picture into its elements (pixels) and performs an analog-to-digital conversion of the object. Starks explains, however, that, "Instead of carrying out our digital analysis of pixels to seven, 10 or 12 decimal places as is done with many A/D-conversion processes, we establish black-and-white thresholds that arbitrarily evaluate all pixels lighter than a certain level as white and all those above that level as black." After that, the data from the electronic image are manipulated according to each application.

John E. Trombly, president of Burlington, Mass.-based Ocktek Inc., presented an example of his company's vision system in a paper at the 1982 Robotics VI show in Detroit. "When combined with a standard vidicon solid-state TV camera and a 16-bit minicomputer, Octek's robot vision module can visually determine

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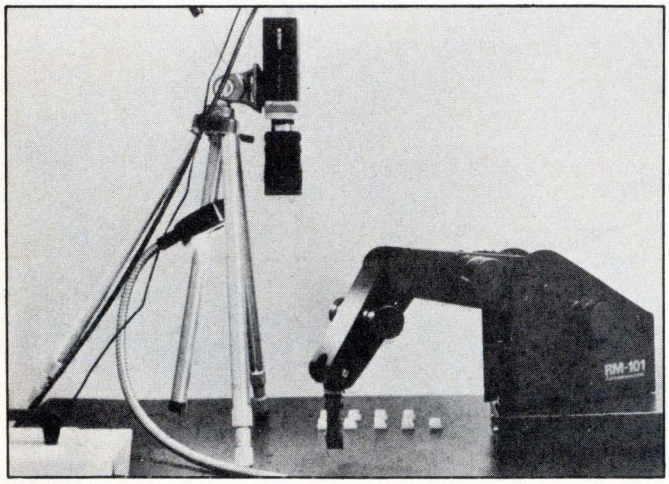
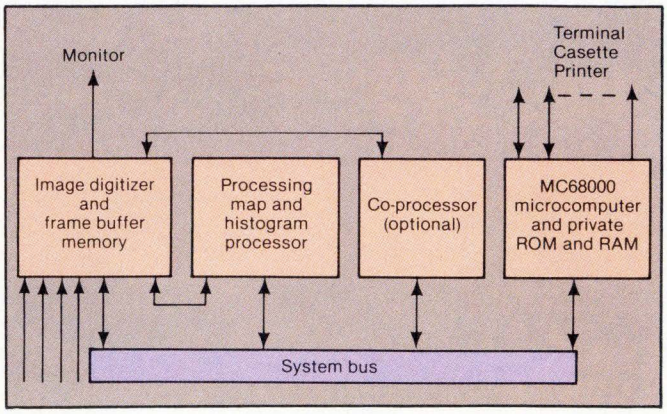


An Octek image-analysis system *directs a robotic arm to pick and sort typewriter keycaps.*



The affordable image analysis system from International Robomation/Intelligence *is a gray-scale vision system for industrial applications and one of several systems using the Motorola MC68000.*

object size, shape and orientation. In addition, the RVM can count the number of holes in an object and classify the size, shape, orientation, etc., of each hole.

"A standard EIA RS178 vidicon or solid-state camera scans the object. Where possible, backlighting is used to provide a high-contrast image. Frontal lighting is used when object surface features are to be extracted. The image analyzer digitizes and stores the scanned image in 1/60 sec. Since the RVM software operates on binary (black-and-white) images, a video input translation RAM is used to establish a threshold. The threshold is usually set empirically; however, it can be interactive for unique site applications. Once the object is captured in image memory, a Signetics 8X300 microprocessor encodes the image. The speed of the coding operation varies with the area of the image windows being processed. A small window, say 128 × 128 pixels, takes about 1/10 sec., while with a full-screen, 320 × 240, encoding is completed in 0.8 sec. The run-length code (used to encode the image) is now available to the host for further processing.

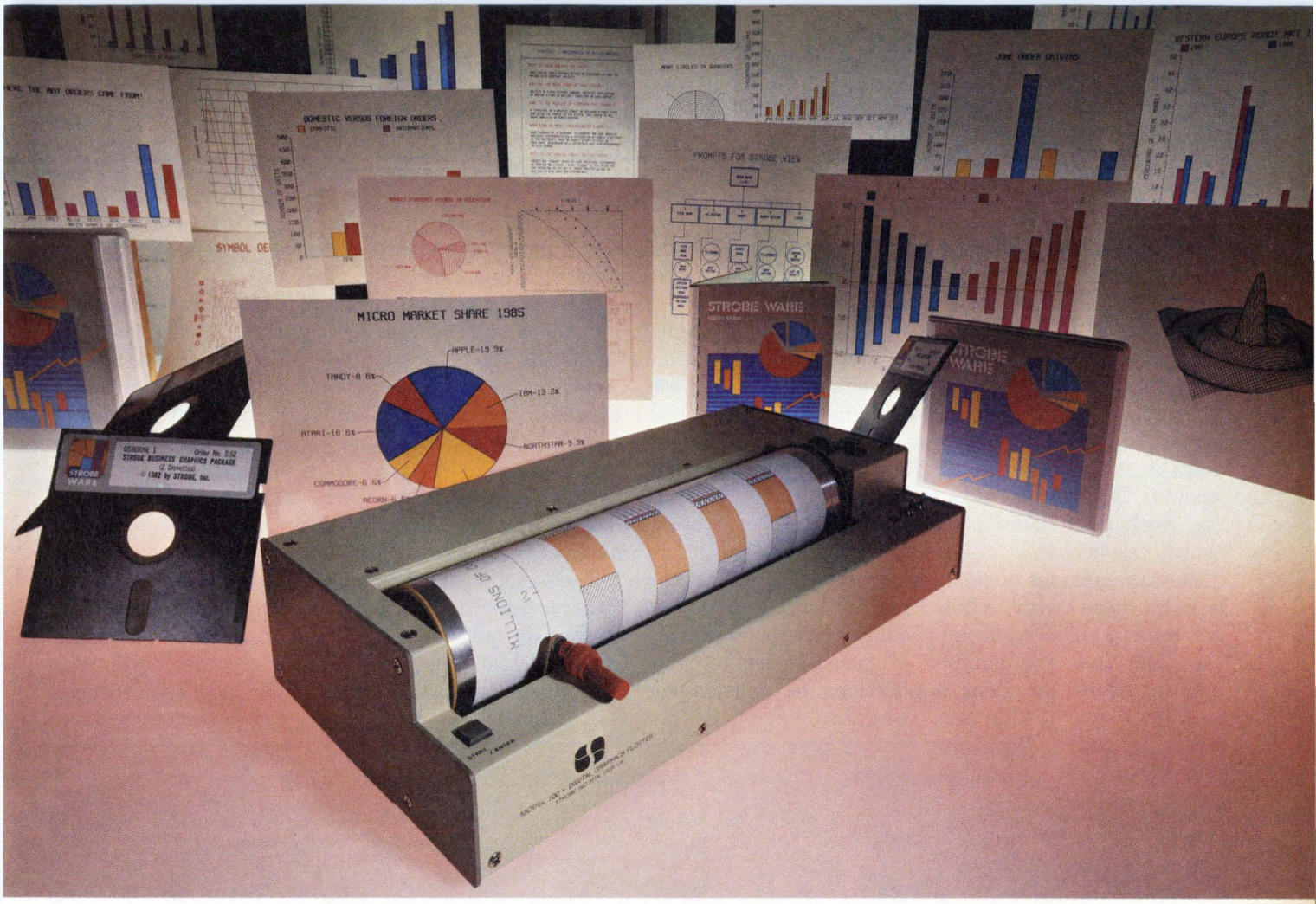
"The image is processed by the host using connectivity analysis, a procedure that breaks a binary image into its connected components. The connectivity-analysis program builds a description of each blob (feature) and its shape. Finally, a number of shape and size feature values characterizing the blob (features) are derived. The connectivity analysis takes about 0.17 sec. and is performed in parallel with run-length encoding. Final feature values are available in about 1/4 sec. from the beginning of a scan for a 128-square window. The processing time is directly proportional to the image area. Thus, a 256 × 256 area requires about 1 sec.," Trombly stated.

When processing is completed, available geometric parameters include: area, maximum width and height, perimeter centroid position, orientation, an elongation index and a compaction index.

The Octek diamond-sorting system for diamond styli in phonograph cartridges consists of a vibratory feeder, a rotating drum, a two-stage stepping motor, a television camera, an image analyzer, a 16-bit minicomputer and a stepping-motor controller. The camera views the diamonds as they pass by, and the image analyzer with the minicomputer extracts the size of each diamond and directs the two-stage stepping motor to position a chute over a sorting vial. Diamonds too short or too pointed are immediately rejected. Accepted diamonds measure an average of 25 mils in length × 6 mils in diameter. Manual sorting required six experienced persons working one shift. They used a calibrated microscope and tweezers to measure each diamond. The vision system does the same amount of sorting in two hours, and the company had a return on investment in about six months.

Another recent entrant, Machine Intelligence Corp., sells the models VS-110 and VS-100 vision systems. The company claims that their systems pass a test of genuine machine intelligence in that the more advance information known about a scene, the more efficiently the scene can be analyzed. The VS-100 uses anticipated knowledge to permit processing speeds as high as 15 complex images per sec. The system can be programmed to identify new objects by placing an object in the viewing field.

Automatix Inc., Billerica, Mass., has been active in both robotics and vision. At the International Machine Tool Show in Chicago last September, the company showed a "no-reteach" software package with a vision-offset option that allowed Automatix robots to locate inexactly positioned parts. After the first part is



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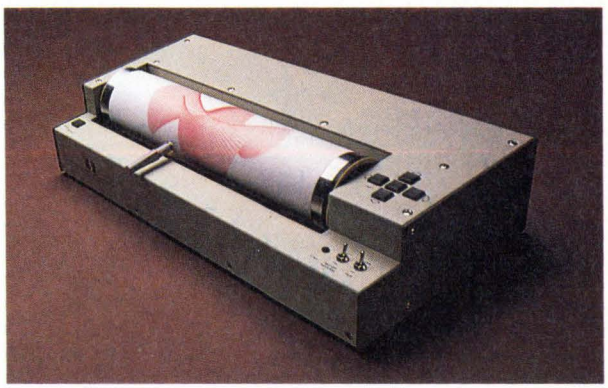

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CIRCLE NO. 120 ON INQUIRY CARD

programmed, the system checks later parts and adjusts the robot's program for variations. The system is used for welding and assembly.

Insight Associates has broken the vision-systems market into seven areas. The first is robotic vision systems, which Insight's Kimberlin calls "the most interesting," but it is not as well-defined as the others. Robots are programmed to go from one place to another, and their only interaction with the external world is through a programmer. Thus, the position of the workpieces must be very accurate. Vision as a sensor can help relax this requirement.

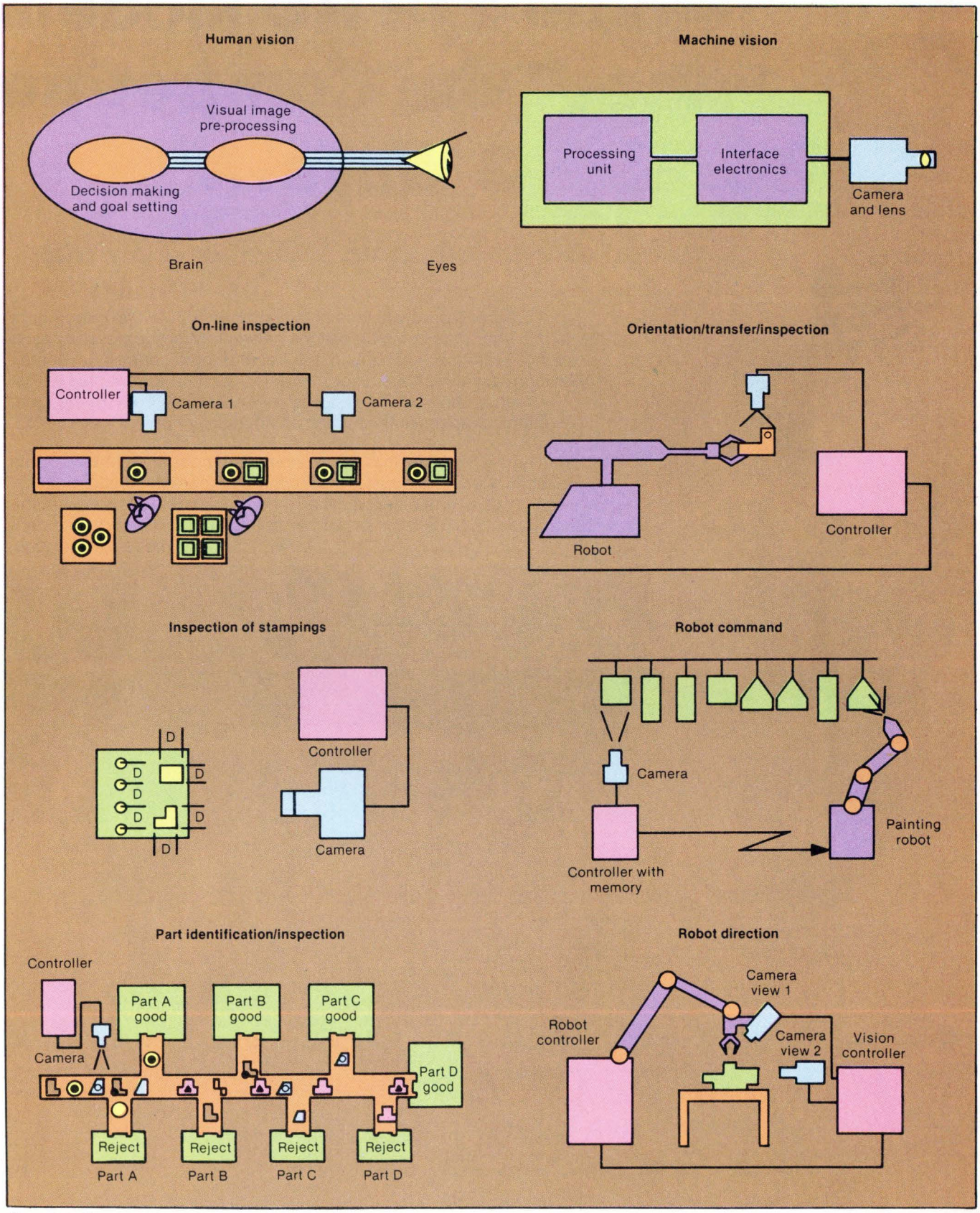
Many companies developing systems that will someday be used with robots market the systems as stand-alone inspection and quality-control systems. "We feel that the number of vision-inspection and noncontact-measurement applications far outnumber the number of robot-assistance applications," says Control Automation's McCraley.

However, the number of vision systems that will tie into robot systems is projected to grow dramatically. According to forecasts by the Robot Institute of America, 15 percent of robots sold to the electrical/electronic and aerospace industries and 10 percent of those sold to the automotive industry will include vision by 1985. Those percentages are projected to mushroom by 1990 to 25 percent, with most systems continuing to be used in the electrical/electronic, aerospace and automative industries.

The second category defined by Insight is vision systems used to direct wire bonders. Wire bonding is a method to connect semiconductor chips to substrate conductor patterns, package pins or other chips. The vision system tells the wire bonder mechanism where

REPRESENTATIVE VENDORS OF ROBOTIC, INSPECTION AND QUALITY-CONTROL VISION SYSTEMS

Company Product	Price	CPU	Image	Notes	Circle No.
Automatix Inc. Autovision II	$35,000	MC68000	N/A	can use 8 television cameras	457
Octek, Inc. Model 2200 Image Analysis Processor	$6263 (10 or more)	Signetics 8 x 300 bipolar μp with 16-bit instruction set	320 x 240, 16 levels of gray scale	plug-in ports for DEC Q-bus- and Unibus-based systems	458
Control Automation, Inc. CAV-1000 Vision System	$19,700	Intel 8086 for vision processing, HP85 for system control	128 x 128 pixels	hierarchical control, RS232C communications, memory for 50 objects	459
Copperweld Robotics, Inc. Opto-Sense	N/A	N/A	N/A	programmed with teach-control module	460
Object Recognition Systems ORS Scansystem, models 100, 200	N/A	Intel 80/10	uses any EIA-RS170 image-sensing device	inspects as many as 3objects per sec. with standard sensor	461
Perception, Inc. MV-100	$20,000	LSI-11/23	binary system based on SRI algorithms	considering MC68000-based systems	462
Machine Intelligence Corp. VS Series	N/A	LSI-11/2	240 x 240 (standard)	can accept images from 2 cameras	463
General Electric Optomate I	N/A	Intel 8080	256 x 256	2-camera capacity	464
Applied Intelligence Systems Pixie 1000	$25,000	Motorola 6809	128 x 128, 64 levels of gray scale	system built on 9 printed circuit boards	465
International Robomation/ Intelligence Image Analysis System	N/A	MC68000	256 x 256	128 gray scale levels	466
Electro Optical Integrated Systems Vuebot 301	$15,000	hardwired TTL	488 x 380	a series of 15 plug-in boards	467



Vision applications from Copperweld Robotics.

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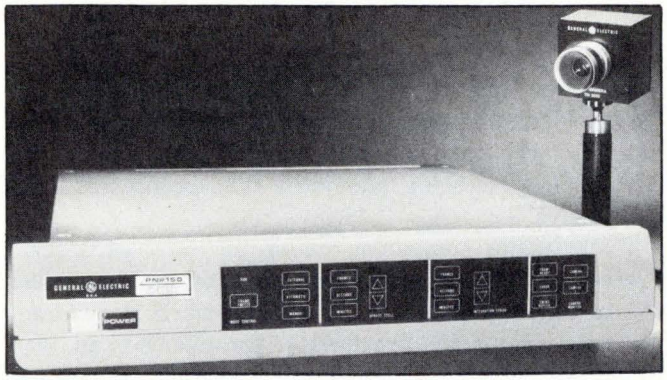


The Optomate I vision memory system from General Electric *can be used as a stand-alone system or be interfaced with other computers to provide instant recall of single-frame video images for inspection or monitoring. The system consists of a GE PN2150 microprocessor-controlled buffer memory and a TN2500 A/D charge-injection-device camera.*

the chip pads are, so the wire can be bonded.

The third category is a "loose collection that I call inspection, detection and control systems," Kimberlin says. These sytems use "pixel counting," which is less sophisticated than the techniques used for robotic vision systems, but has a wide range of applications including labeling, assuring that stamped parts have been punched correctly and checking displays and LEDs.

The Prothon Division of Video Tek Inc., Parsippany, N.J., has recently started selling a system that Kimberlin would place in the IDC group. The Prothon 1000 carries an OEM quantity price of $5000 and is aimed at inspection, measurement, process-control, sorting and monitoring applications. Prothon president Peter Mick explains that an initial test-market mailing drew more than 1500 responses, including inquiries from "all the Fortune 500 companies."

The clutch manufacturer that sells parts to GM for automatic transmissions uses a Prothon system. Mick says that as a result of increased demand for quality control, GM is putting "extreme pressure" on its suppliers to meet rigid quality standards. Rather than risk losing contracts, suppliers are turning to quality-control systems. The risk of losing a contract is so great that the cost of the inspection system becomes insignificant, Mick says.

The fourth category is video inspection systems. Unlike the first three categories, inspection in an off-line operation in which a part being inspected is removed from an assembly line and examined for proper dimensions and fabrication.

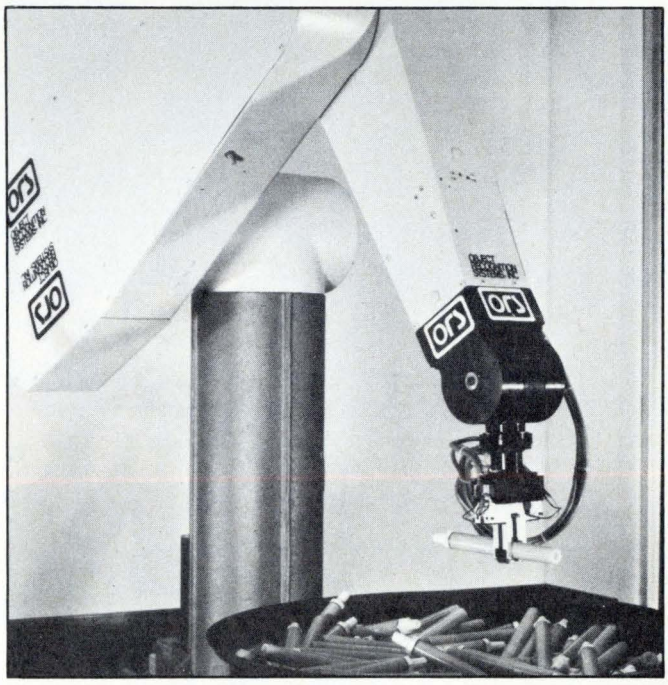
The fifth category, also an off-line operation, is micro-measurement systems. Their only application is measuring the line width on wafers during semiconductor manufacturing. The sixth category, which includes PC-board inspection systems, is relatively undeveloped, but extensive R&D is occurring. At one level are various kinds of bare-board inspection systems that discover whether a board contains shorts, has been improperly etched or has other cosmetic defects. Visual inspection of PC boards has traditionally been a bottleneck in production because, while the fabrication of PC boards is highly automated, inspection remains a nonautomated, labor-intensive operation. PC-board inspection will become more important as more multilayer boards come into use.

Two other areas fall into the PC-board-inspection category: inspection of stuffed boards to make sure the correct components have been inserted and inspection of artwork that has been prepared by automated CAD/CAM systems for PC-board design.

The seventh market sector, image analysis, involves an operator's interpreting an image displayed on a CRT screen.

The $29.4-million market figure for 1981 and the projected $1-billion 1991 figure do not include vision-directed wire bonders or image analyzers. Kimberlin expects that the robotic-vision-system market will be the fastest growing of the seven categories.

In 1981, vision systems going to on-line applications (robotic vision systems, IDC vision systems, wire bonding) had an edge over off-line systems (video inspection, micro-measurement, PC inspection and



Connected to this Unimation robot is an ORS vision system designed by Object Recognition Systems, Inc., *that enables the robot to pick up a cylinder from among parts randomly oriented and jumbled together in a bin, a new capability called "bin-picking."*

image analysis) in usage, with the on-line share at 54 percent of installed units. By dollar value, the on-line categories represented $14.3 million of the $29.4 million in total shipments. "When the decade ends, it will be no contest at all; on-line systems—paced by their teaming with robots in assembly applications—will predominate both in dollar value and unit volume," Kimberlin says.

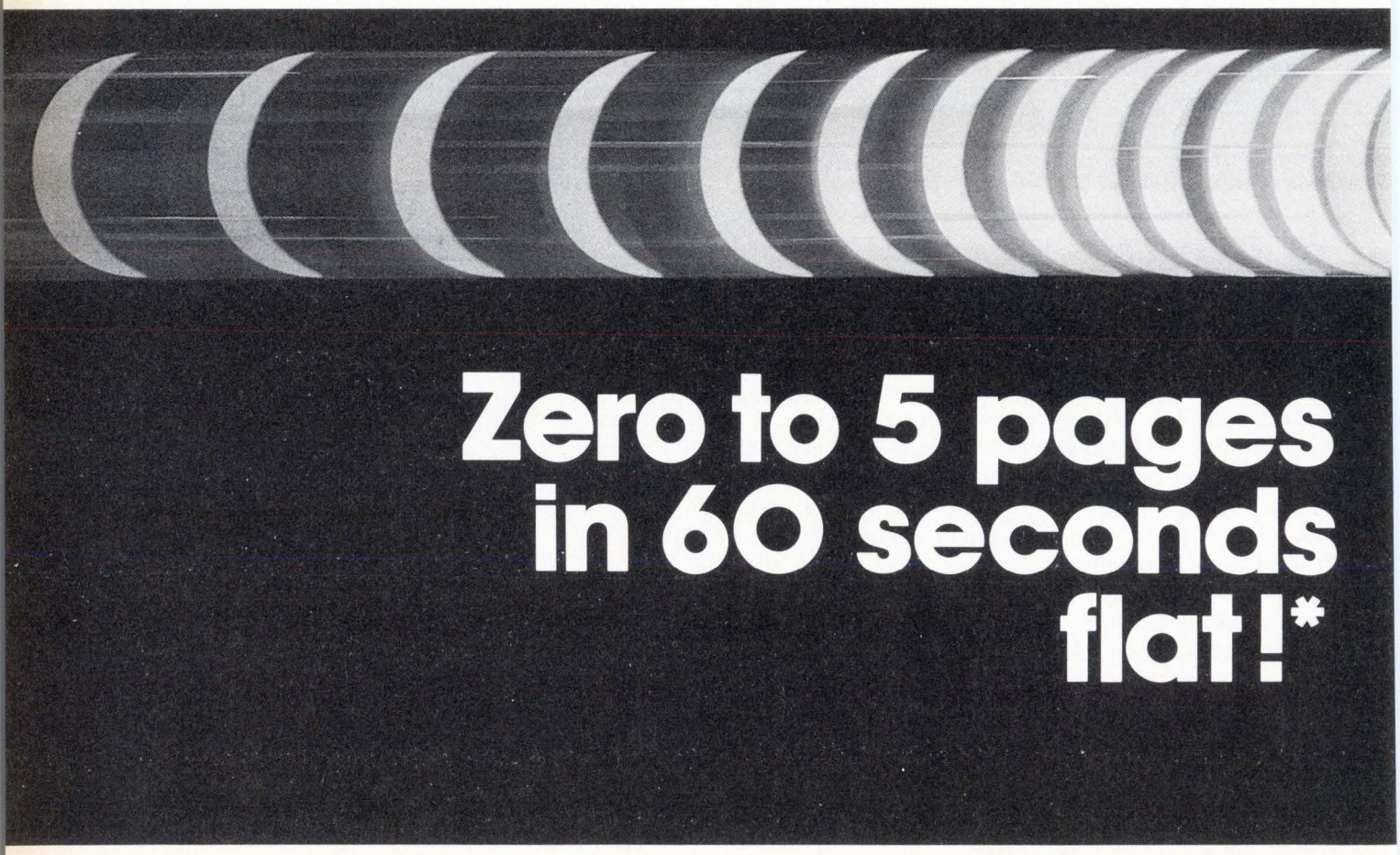
There is also a split between customized and standard products. Although the custom type dominated the 1981 market for on-line systems, accounting for $8.8 million of the $14.3-million total, standard products will prevail in both dollars and units after 1983, Kimberlin says.

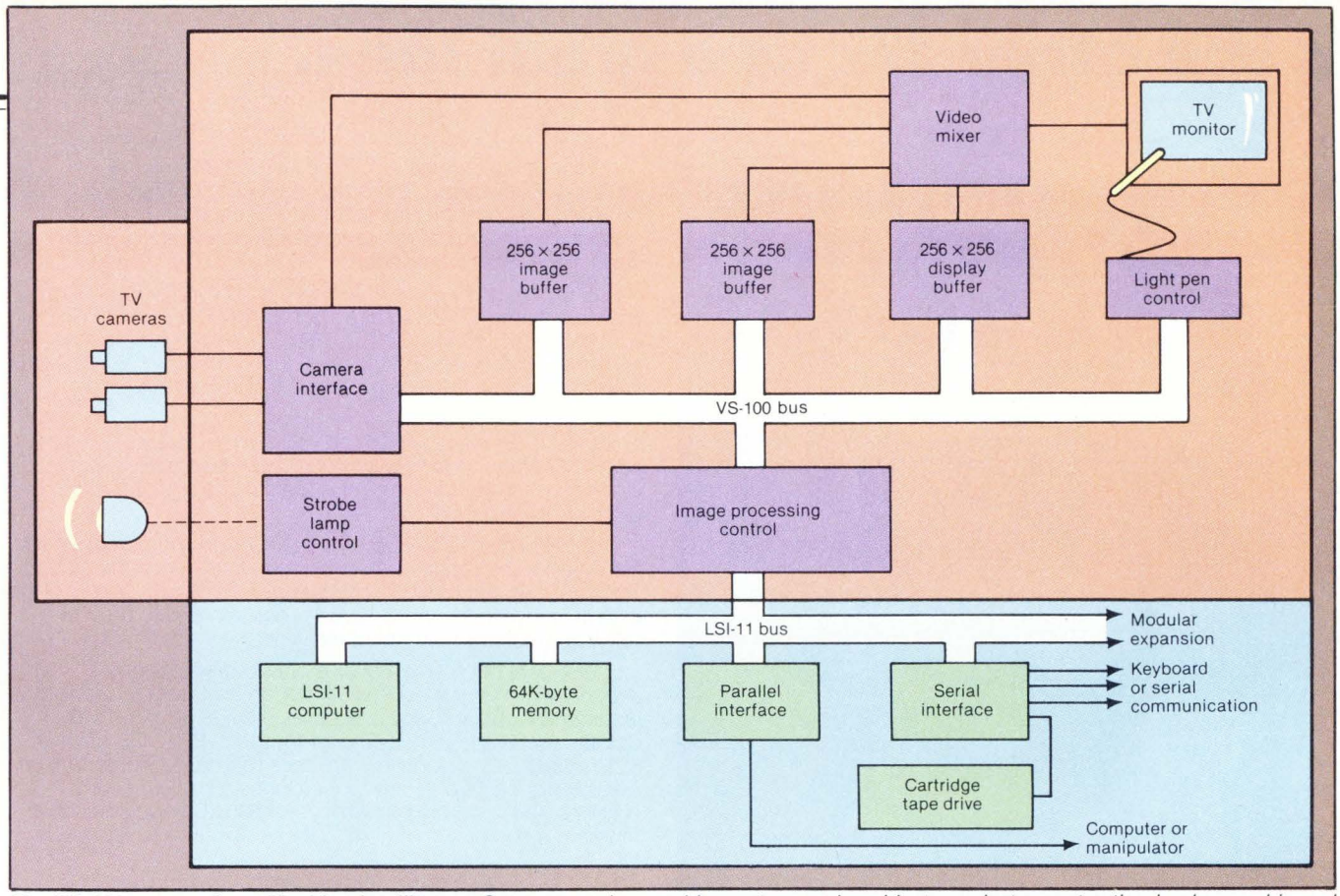
Many of the binary vision systems on the market are technically based on the S.R.I. algorithm developed at Stanford University. Much of the ongoing research involves developing faster algorithms with hardware and software configurations that can perform the computations faster.

Insight's Kimberlin says most vision systems use binary processing, which sets a threshold for recording a given pixel as either black or white. "With binary processing, you are throwing away a lot of needed information such as texture, color and shadows. In thresholding, the data are susceptible to variations in light intensity and changes in contrast in the workpiece. Gray-scale processing alleviates that problem," Kimberlin says.

While many companies claim to have gray-scale processing, Kimberlin dismisses most as simply moving the threshold parameters to obtain the best reading. "In true gray-scale processing, for every pixel, you would not only record the x and y location, but would also have to provide and store information about the intensity level to develop information about the workpiece," Kimberlin says.

One major area that requires further advances is developing higher operating speeds, Kimberlin says. "Vision systems don't really operate fast enough to do a list of applications involving robots. If you have a continuous controlled robot, you want to do that control on the basis of visual information. I've recommended the incorporation of some fast pre-processing hardware," he says. □





The VS-100 system from Machine Intelligence Corp. *recognizes and inspects complex objects against a contrasting background in real time.*

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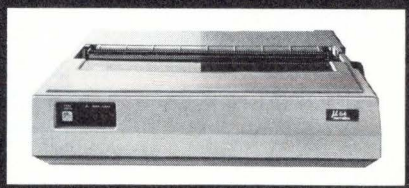

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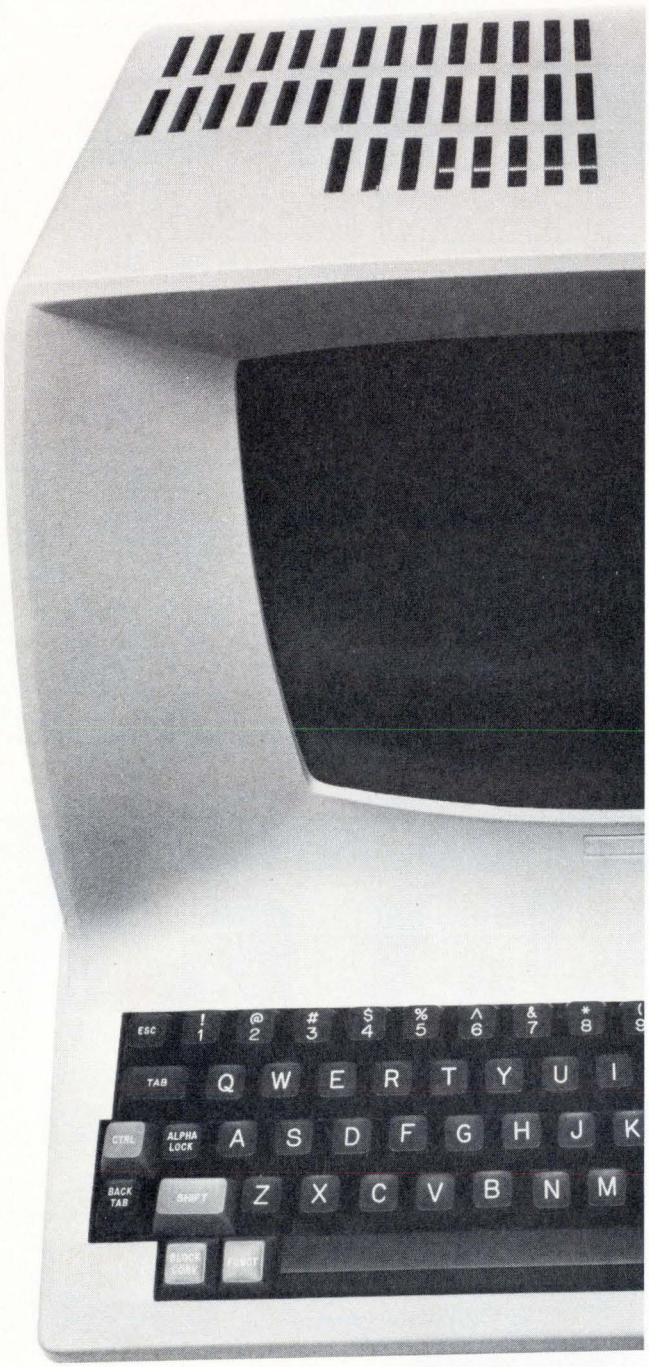

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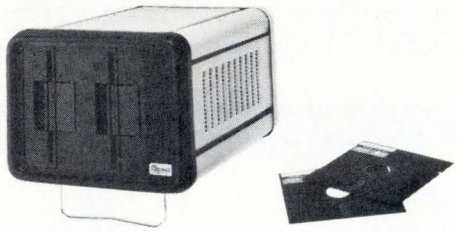

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Franklin Computer and micro-MRP plan for the future

By Frank Catalano

As Franklin Computer Corp.'s efforts to sell an Apple II-compatible computer continue in courtrooms and storefronts, the company has enlisted a manufacturing planning system for aid in building the computers cost-effectively and with proven quality.

In the latest legal go-round, Franklin appeared the winner when a court decision allowed it to continue to market its Ace 1000 personal computer over Apple Computer, Inc.'s objections. That decision, which by no means ended the legal wrangling between the two companies, has aided Franklin's push to sign independent retail stores to add the Franklin line. If that push is successful—and industry reports of dealers signing with Franklin are a nearly daily occurrence—the company will have to build many more computers than it has so far in its 10-month history. Franklin officials predict a tripling in orders over the next six months, and they hope that by using the planning system, the anticipated avalanche of orders will not bury the company.

Franklin of Pennsauken, N.J., began shipping its Ace 100 microcomputer last May, and its 64K-byte version, the Ace 1000, a few months later. By September, monthly shipments reached 1000 units and, judging by orders, that figure should balloon to 3500 units a month by next March, the company estimates. Russ Bower, vice president of manufacturing at Franklin, says, although Franklin is a less-than-$10-million company, it is projected to grow into a $30-million company in the next six months.

In preparation for growth, Franklin has expanded its production facility this summer from 2000 to 20,000 sq. ft. and its production staff from four to 57 workers. "It was obvious to us right from the start that we needed a computer to run the large-scale manufacturing operation that we envisioned at Franklin," Bower says. "We needed a system that provides immediate and accurate data with which to improve production scheduling, cut inventory costs and enable us to be prepared for changes in the business when they occur."

Franklin would not have been able to afford such a system without the availability of microcomputer-based MRP packages. While minicomputer- and mainframe-based MRP systems sell for more than $200,000 for hardware alone, Franklin's new system is expected to cost less than $50,000, including hardware, software and consulting fees.

Like most electronics companies, Franklin's production operation involves assembly more than manufacturing. *Workers use automated and semi-automated equipment to stuff motherboards and controller boards with ICs, and package the boards into the proper housings.*

Designed by Ernie Pennente, president of Online Applications, Inc., Haddonfield, N.J., Franklin's MRP system includes a 16-bit Alpha Micro Systems computer, two Hazeltine Corp. 1420 terminals, two Data South 180 printers, two Control Data Corp. Hawk Winchester drives and the IMPAC MRP package from McCullough & Associates, Excelsior Springs, Mo.

By cutting inventory costs, the system will pay for itself within the first year, Pennente says. "If Franklin can cut its $1-million inventory by 10 percent, the company can save $100,000," he says. "That savings will continue to be realized year after year."

But inventory-cost savings are only one of the benefits that MRP will bring to Franklin, says Pennente. He explains that MRP ties production and inventory data into a closed-loop system with financial data and provides management a tool for running the entire company.

If orders fall off for one month, for example, the MRP system warns the production department to delay production of a subassembly or finished product that is in ample supply in inventory, alerts the purchasing department not to order the normal quantity of parts because production has slackened and projects to

Electronic components such as ICs, resistors and capacitors are stored in inventory at Franklin's production facility *with subassemblies such as circuit boards and molded-plastic housings. With its new MRP system, Franklin hopes to cut inventory by 10 percent and save $100,000.*

management how the order decline will affect profits. Should the order rate drop sharply, the MRP system tells management how long the company can survive despite profit losses. The system also works in the other direction to forecast and plan for growth.

"The key word in MRP is planning," says Pennente. "MRP takes production and inventory control a step further and lets users know how production and inventory levels should change depending on customer orders."

Other benefits that Franklin hopes to derive from its MRP system include improved servicing of customer orders through better production planning, reduced storage space for inventory, improved accountability and reduced time to move parts and subassemblies from one area of the plant to another.

However, Pennente warns, "No matter how sophisticated your MRP system is, it will fail without a commitment from above. The management at Franklin was very concerned about having as much automation as possible to help the business from the start. They knew the company was going to grow and wanted to have all the tools in place to accommodate that growth."

Rather than divert in-house engineering resources from new-product development, Franklin's management hired Pennente to select hardware, evaluate software and implement the system. Last February, Pennente's first task was to evaluate the hardware that the company had on hand. He found the company's Alpha Micro computer, with 160K bytes of RAM, six serial ports and an operating system "as sophisticated as Digital Equipment Corp.'s RSX-11M" and powerful enough to run an MRP program of the size that Franklin required.

Having selected the computer, the software decision was easy, Pennente says. McCullough's IMPAC package was designed specifically for the Alpha Micro computer and, Pennente says, was easier to implement and less expensive than other microcomputer-based packages on the market (MMS, July, p. 145). The package is available in seven modules—general ledger, accounts receivable, accounts payable, inventory control, bill of materials, purchasing and order entry—and is priced at $3000 per module. "Compared to other systems selling for $100,000 or more, IMPAC was a bargain," says Pennente.

Pennente started implementing the MRP system in April. This involved building a central database consisting of parts information on each of the 450 components and subassemblies that comprise the ACE 100 and 1000 microcomputers. Such information included a bill of materials detailing the components that are used in each subassembly of a finished product, the vendor of the components, their price, the quantity purchased and the quantity in inventory.

Data are entered via four CRT terminals throughout Franklin's production facility and are stored on hard disks. Pennente says approximately 15M bytes of data is stored on disks, and by the end of this fiscal year, approximately 20M bytes will be loaded.

Pennente says that building a database requires only a general knowledge of the various departments within the organization, but maintaining that database to provide accurate information is difficult and requires discipline on the part of the users. "The three things you need before you can benefit from MRP are accurate inventory records, accurate bills of materials and accurate production schedules based on your shipment forecasts," says Pennente. "If your MRP system has inaccurate information, all it is able to do is spit back bad data faster than manual record-keeping methods."

To assure accurate records, Pennente says, the proper data must be entered into the MRP system on an ongoing basis. Additions to and deletions from inventory must be logged along with new-product and vendor information. The time between when relevant data are received and entered should be minimal, as should the number of people that handle the data before it enters the computer.

"Terminals should be available to the people responsible for inputting data so that that data can reach the computer as quickly as it comes in," says Pennente. "The sooner the data are captured and the fewer hands the data pass through, the smaller the chance for error."

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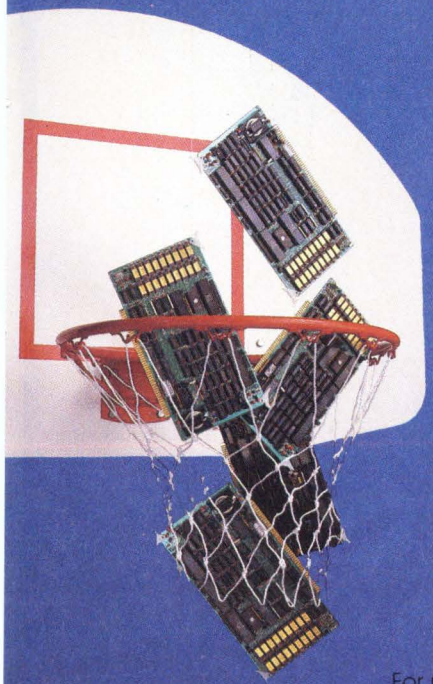

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Pennente says the discipline to maintain an MRP system is "a million times more difficult to master than the actual technology behind MRP," but adds that, because the system is being implemented early in the company's history, the discipline will be easy to instill. "People haven't had the time to develop bad habits," says Pennente. "The MRP system will become a normal part of their day-to-day jobs."

To accelerate the education, Pennente recommended that Franklin's upper and middle management attend courses given by Oliver White Education Associates, Inc., Newbury, N.H. Prices for the three-day course for top management and the five-day course for middle management were $975 and $1175, respectively. They taught users not only what MRP is, but also how it should be implemented, maintained and used.

After attending the top-management course, manufacturing vice president Bower was able to enter all the bills of materials into the system and to maintain his portion of the database, regularly checking it for accuracy. Bower says that he now uses the system to extract data to make daily decisions. "Frankly, I wasn't adept at using a computer, and made most of my decisions by the seat of my pants," he says. "Now, I feel pretty comfortable with the system."

Production manager Dan Ludwig, who attended the middle-management course, says he is eager to use the MRP system because it will provide him with precise data with which to plan production schedules and forecasts. "I've been making decisions in my head without any real input from the other departments within the organization," says Ludwig. "Now, I'll have a closed-loop system to bring the whole ball of wax together. My decisions will be based on hard-core data from all areas of the business, instead of on estimates."

Pennente has implemented six of the seven modules of the IMPAC package and hopes to have the seventh module—order entry—up and running by December. He says that a normal installation usually takes 18 months, but because of Franklin's size and management enthusiasm, he completed the task more quickly. □

Frank Catalano is a Boston-based business writer specializing in factory-automation topics, and a former associate editor at *Mini-Micro Systems*.

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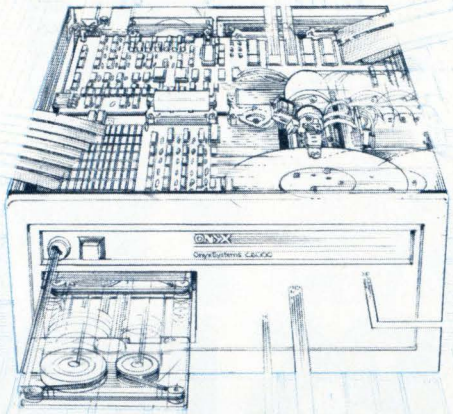

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And, as developed, the ONYX C8002 features expandable memory up to 1 Mbyte, and disk storage up to 160 Mbytes on-line. Its cartridge tape backup offers cyclical redundancy checking on every backup. Both the Winchester disk storage system and the cartridge tape backup are *internal.*

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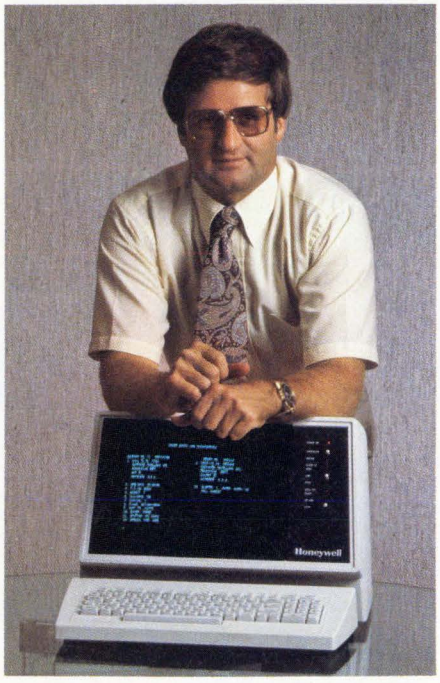

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CIRCLE NO. 126 ON INQUIRY CARD

Computers add intelligence to machine-tool muscle

By Frank Catalano

With their twin advantages of lower cost and greater flexibility, microprocessor-based computer-numerical-control systems are starting to overpower the prevalent hard-wired numerical-control devices that are used to regulate machine tools. The same forces that aided the microprocessor incursion onto minicomputer turf in business appear to be at work in the machine-tool industry in which four of the five top CNC suppliers now champion Intel Corp.'s 8086 microcomputer. The lone holdout, Allen Bradley Co., still claims an off-the-shelf micro can't beat a specialized homegrown mini.

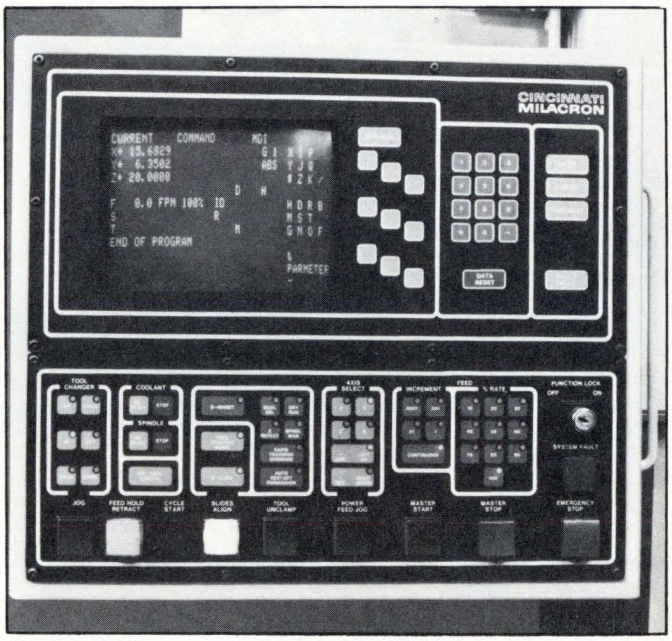
"Computers have virtually taken over the machine-tool industry," says James Gray, president of the National Machine Tool Builders Association. "By the end of this decade, every machine-tool builder will incorporate computers into their systems." Machine tools, including drill presses, grinders and lathes, are used to shape, form or cut metal.

A variety of CAD/CAM, CNC, programmable-controller and robot systems were a part of the 1216 machine-tool exhibits at September's International Machine Tool Show in Chicago. Machine-tool builders from 30 nations displayed more than $650 million worth of equipment. Most of the show's technical sessions and seminars concerned the use of computers and robots in industry and the design of computer-based flexible manufacturing systems. The microprocessor-based computer-numerical-control systems displayed provide factory users with a precise means of controlling machining cells in production facilities and linking those cells to a central computer.

Tom Tremblay, senior consultant with Technology Consulting Group, Boston, predicts that microprocessor-technology advances will cause the average price of CNC systems to drop from $23,000 in 1976 to $15,000 by 1986. He also expects the number of installations to increase 12 percent by 1986 from a 1981 total of 14,000 units.

Tremblay ranks General Electric Co., Allen Bradley Co., General Numeric Corp., Bendix Corp. and Cincinnati Milacron as the market leaders. GE and Bendix sell systems to machine-tool builders and incorporate them into their own products. Cincinnati Milacron provides CNC systems only to its own machine-tool division.

Numerical-control and CNC systems were designed to control metal-working machine tools, which produce various parts in small quantities. Because of their wide range of applications, machine tools require flexible controls that can be reprogrammed with each new job. Before the 1955 introduction of NC systems, operators manually controlled machine tools through wheels and gauges. The operation fell victim to human error, and production quality often varied with each machine adjustment.

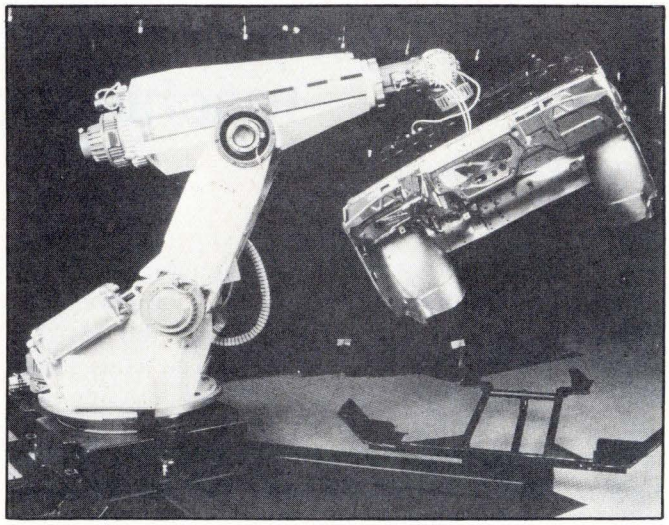


Cincinnati Milacron's Acramatic 900 MC CNC system *is used only on the company's own machine-tool products. The Acramatic's CRT terminal provides a menu display that guides users in operation and alerts them to machine breakdowns or maintenance requirements.*

NC controls ease the burden on operators and place it instead on programmers. A paper tape containing a part program that controls the motions of a machine is usually generated on a mainframe and then transferred to the NC. Because the NCs are hard-wired and do not include memory or mass-storage capabilities, the tape must be reused each time its part program is required, and a new tape is needed for each program adjustment. The tape often rips between uses or gets jammed in the tape reader. Each time the tape is destroyed, a new one must be generated, leaving the machine tool idle.

CNC alleviates those problems by storing part programs in nonvolatile CMOS or bubble memory. Paper tape is used only to transfer the program to storage. CNC systems are intelligent, allowing operators to edit

General Electric's new Mark Century 2000 CNC system *can interface to other factory computers through GNET or through an RS449 port. The Intel-based system uses the 8086 to handle main processing functions.*



Among the computerized systems on display at the International Machine Tool Show was General Electric's GP 132 robot. *The robot can be used for welding, deburring, polishing, grinding, sealing and assembling and has a payload of 132 lbs.*

and write part programs for each application. NC does not allow for editing.

In addition to editing capabilities, CNC devices provide a communications link between a central factory computer and machine tools. The link enables the computer to down-line-load a part program to machine tools throughout the factory or to gather production data from the machine tools for quality control, maintenance or manufacturing resource planning.

A new Mark Century 2000 CNC system from GE interfaces to central computers via GNET, GE's factory

WESTINGHOUSE UNVEILS DEC-BASED PART-PROGRAMMING CENTER

To bolster its offerings in its Industry Automation Division, Westinghouse Electric Corp. has turned to Digital Equipment Corp. In doing so, Westinghouse might be one of the first industrial companies to offer the recently introduced DEC Professional Series 350 in a factory system.

A DEC PDP 11/23-based part-programming center, priced at less than half the cost of most mainframe-based systems on the market, was introduced at the International Machine Tool Show by the Industry Automation Division of Westinghouse Electric Corp., Pittsburgh. Westinghouse plans to incorporate the software for the new system in DEC's Professional Series 350 as soon as that unit is available in production quantities.

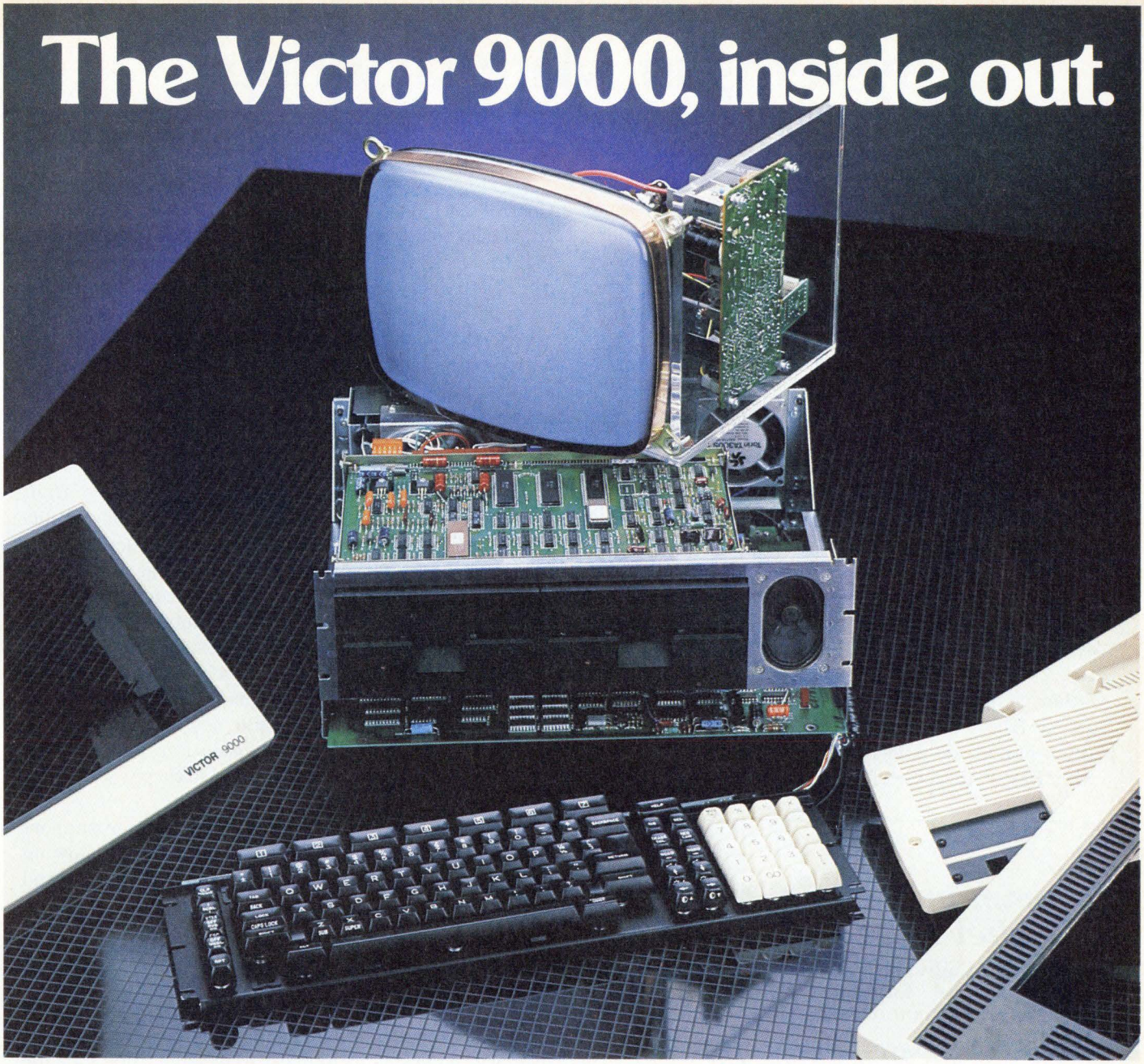
Part-programming systems generate the application software that enables CNC systems to control machine tools. Software is usually generated on paper tape and then stored in the nonvolatile memory of the CNC equipment. Westinghouse based the part-programming system on DEC equipment because of the number of DEC systems installed in factory settings, says Alan Murray, senior systems engineer at Westinghouse.

High-priced mainframe-based systems have previously forced most users to rely on time-sharing services to develop parts programs. But the new system will make parts programming affordable to users on an in-house basis, says Murray. "Now, users will have control over their costs and their parts programs," he says. "And in the deal, they'll get a general-purpose computer that they can use to do their payrolls, accounts receivables or whatever."

The system includes the DEC 11/23 PLUS computer, a dual-drive DEC RL02 disk subsystem with two 10.4M-byte removable cartridge disks, a 30-cps paper-tape punch/reader, a DEC VT-125 CRT terminal, a Hewlett-Packard Co. 9 × 12 bed plotter, a DEC Decwriter III printer and all operating-system and application software. The system uses DEC's RSX-11M operating system and is programmed in FORTRAN 77. Prices range from $64,950 for a five-axis, sculptured-surface part programmer to $54,950 for a three-axis system. Users who already own DEC equipment can purchase the system software separately. Murray says that when Westinghouse begins selling the system with DEC's Professional Series 350 microcomputers, prices will drop by as much as one-half.

"When DEC announced the Professional series based on the PDP-11 chip set, we immediately ordered development units," says Murray. "We'll probably offer the part programmer on the 350 in November."

The Victor 9000, inside out.



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networking system, or through an RS449 port. Werner Rieben, manager of product planning for GE's Numerical Control Division, says GE is developing software that will allow the Century 2000 to extract production data from a machine tool and then transfer that data to a host computer. "GE views CNCs as the basic components in a factory that will link all the machine cells," says Rieben.

John Deam, technical director of the National Machine Tool Builders Association, says that, judging from the CNC systems exhibited at the National Machine Tool Show, the major trend is toward systems in which a CPU handles the main tasks, and distributed processors handle peripheral chores. Bendix uses an Intel 8086 as the CPU in its CNC systems and an 8085 to handle communications between an operator and the CNC and the CNC and the machine. An 8088 controls basic machine variables such as spindle speeds and feed rates.

Other companies using the 8086 include GE, General Numeric (the U.S. marketing arm of Siemens Corp. and Fujitsu-Fanuc) and Cincinnati Milacron.

Stan Berry, director of engineering for the Industrial Control Division of Bendix, attributes the 8086's popularity to its computing capability and Intel's timing in introducing the chip—the first 16-bit microprocessor available. Berry says the 8086 is powerful enough to provide a single-chip solution in applications that previously required several 8-bit chips. "Most of us had a good warm feeling that Intel was going to back up the 8086 with a lot of peripheral chip support like a math processor, I/O processors, interface chips and high-speed serial port chips," says Berry. "Intel was there ahead of Motorola with a lot more stuff."

Allen Bradley's Numerical Control Business Division offers its new 8200 CNC system on a minicomputer, rather than a micro. Ken Burger, product marketing supervisor at the company, says this is because minicomputers provide more powerful computing. The company developed its own minicomputer because no other system on the market was designed to interface directly with a machine tool, and the company wanted flexibility in controlling the instruction set of the system. "When we want to add new instructions for new features we develop, all we do is reprogram the PROMs," says Burger. "We lose that luxury when we go to an off-the-shelf computer."

Heinrich Vogelesang, director of customer support for General Numeric, says that, besides following advances in microprocessor technology, another trend in the CNC industry is increased part-program storage. While early CNC systems could store as few as two part programs, the General Numeric 8 series system stores as many as 100 on an Intel bubble memory.

The National Machine Tool Builders Association's Deam notes that suppliers use bubble memory for large memory requirements and less expensive CMOS RAM for smaller jobs. He says that CNCs are equipped with nonvolatile memory because such memory does not involve moving parts that break down easily in manufacturing applications. "If you lose your memory, you lose your part program," says Deam. "If you lose your part program, you lose your production capability."

Although some machine-tool builders displayed manually controlled and NC-equipment at the show, most systems were computer controlled, Deam says. He expects CNCs incorporating 32-bit microprocessor chips that provide even more computing power than the current generation of systems to appear soon. □

Frank Catalano is a Boston-based business writer specializing in factory-automation topics, and a former associate editor of *Mini-Micro Systems*.

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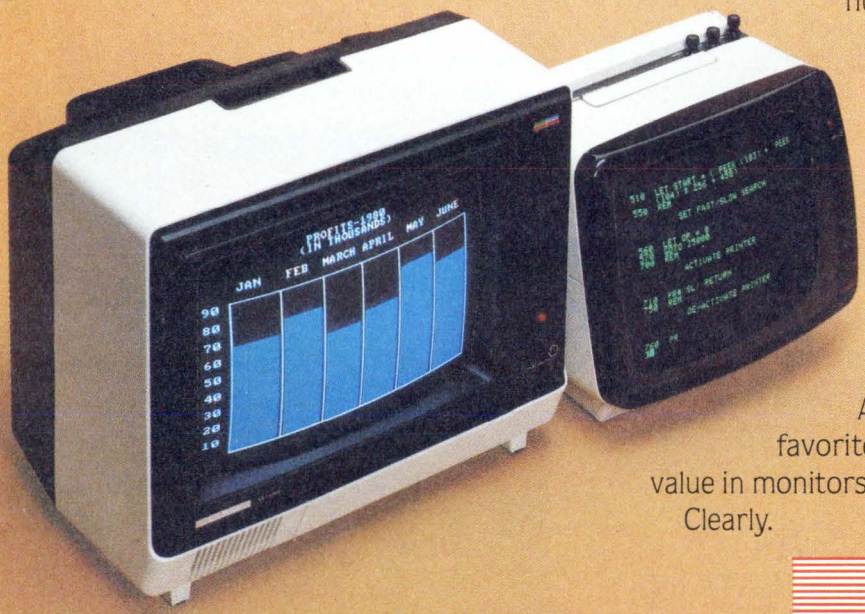

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Mini-Micro Systems

Peripherals Digest

FALL 1982

THE INDUSTRY SOURCE BOOK FOR COMPUTER SYSTEM INTEGRATORS

Printers

Disk and diskette drives

Alphanumeric display terminals

Directory of manufacturers

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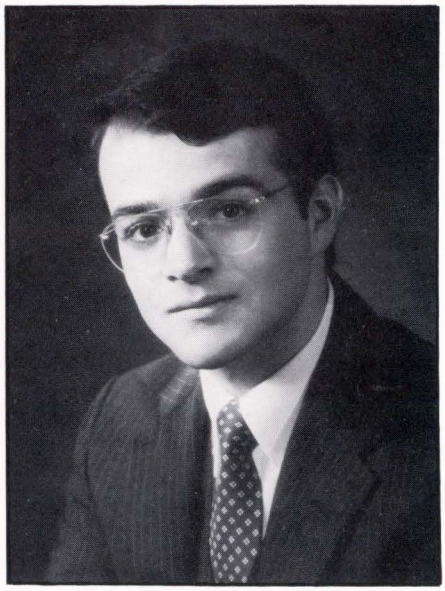
Keeping up with our industry



Mini-Micro Systems has been tracking the computer peripherals industry on a monthly basis for 15 years, and we're still awed by its commercial and technical vitality. The combination of readily available venture capital and American and foreign innovation has spawned new peripherals manufacturers at an amazing rate. The spectacular successes of some of these start-ups and the immense demand for low-end peripherals have lured many of the larger computer companies into the peripherals business.

Keeping up with product and pricing developments in the numerous peripherals industries is a difficult task for competitive strategists and end-user buyers alike. Reading a mix of weekly, biweekly, and monthly trade magazines can keep you on top of breaking developments. Subscribing to expensive loose-leaf reference services can provide somewhat dated background information on major products. The *Peripherals Digest* combines the reference content of the loose-leaf services with the regularity, currency and editorial content of a trade journal.

This first edition covers line and serial printers, hard and floppy disk drives, and alphanumeric terminals. It combines "How to Select . . ." tutorial articles written by leading peripherals marketers with *Mini-Micro Systems*-style product tables covering more than 1000 products from roughly 400 companies. The product tables reflect some 700 survey questionnaires and almost double that number of follow-up phone calls, coordinated by a microcomputer system running relational database software.

Thanks to the computer, we won't forget anyone we listed this time when it's time for the April 1983 edition, but if you know of a company or product we should cover but haven't, send us a postcard and we'll get it in for April. As we go to press we know the *Peripherals Digest* is the most current, complete, usable and editorially rich reference of its kind. We intend to keep it that way.

Patrick Kenealy

Patrick Kenealy
Associate Editor

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How to use the Peripherals Digest

The Peripherals Digest is designed for ease of use by novice and veteran systems integrators alike. It is divided into four tabbed main sections: a printer chapter, a disk/diskette chapter, an alphanumeric terminal chapter and a directory of manufacturers.

Each of the three product sections has three subsections:

- a market overview compiled by Mini-Micro Systems editors;
- one or more "How to select . . ." articles written by leading peripherals marketers experienced at matching hardware to user requirements;
- one or more product pricing and specification tables arranged alphabetically by company, compiled by computer, and based on surveys mailed in August and September, 1982.

The directory of manufacturers is the last section of the Digest and is a consolidated alphabetical listing of all the vendors listed in the three product chapters. Each directory entry provides a vendor's mailing address and telephone number, as well as a circle number for the reader service card. Each entry is also keyed with the letters P, D or T to indicate whether the vendor makes printers, disks and/or terminals.

To use the Peripherals Digest most effectively, use the tabs to find the right section quickly.

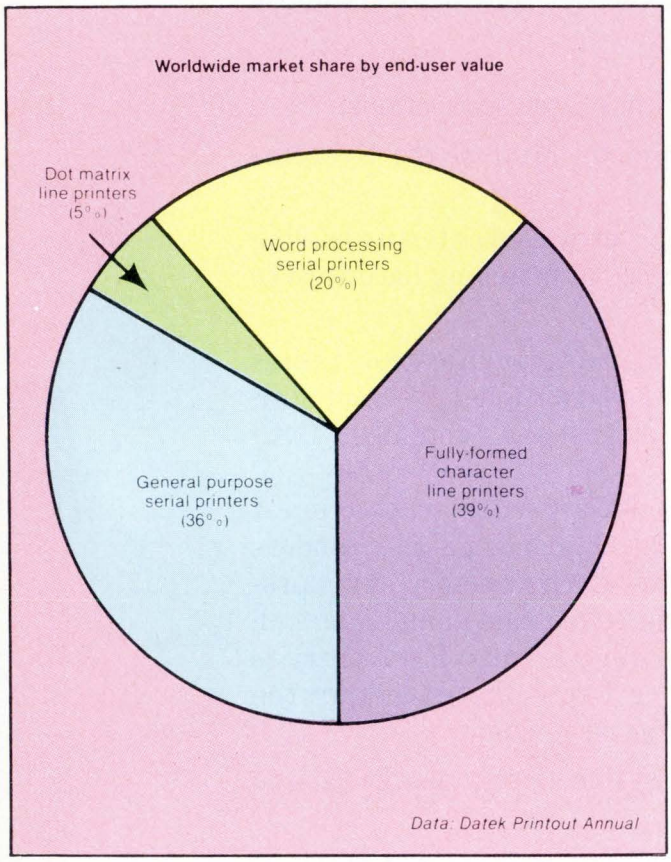
To find addresses or phone numbers: use the directory of manufacturers.

To check prices or specifications:
- turn to the appropriate section,
- find the appropriate product table,
- find the vendor alphabetically.

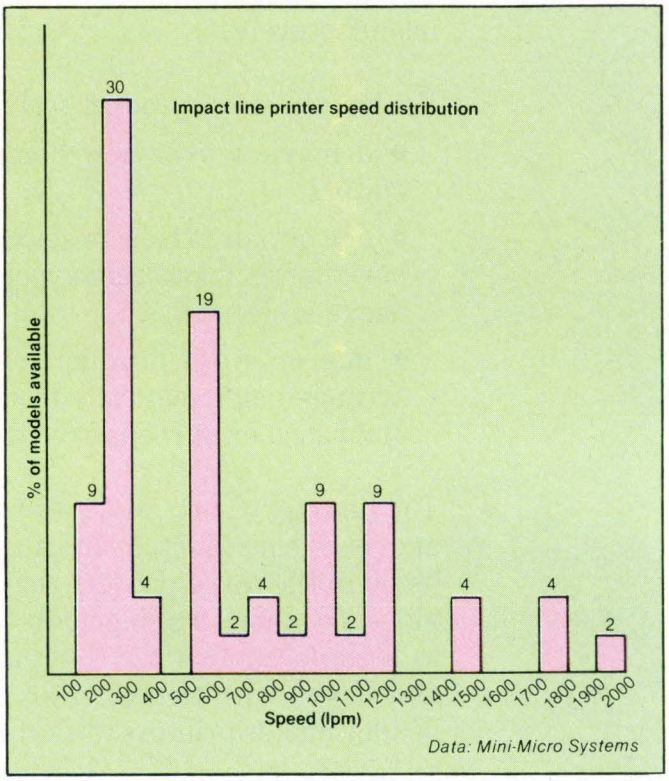
To select a peripheral:
- turn to the appropriate section,
- check the market overview
- read "How to Select . . .,"
- refer to the product tables to rule out inappropriate products,
- refer to the directory of manufacturers to find where to contact prospective suppliers.

To comment on the Digest or suggest future chapters or entries, contact the Editor, Mini-Micro Systems Peripherals Digest, 221 Columbus Avenue, Boston, MA 02116.

Printer market overview



The 1981 revenue shares of the $4.6-billion worldwide impact printer market *reflect healthy sales of impact matrix and daisy-wheel serial printers and sluggish (economy-related) sales of impact line and non-impact page printers.*



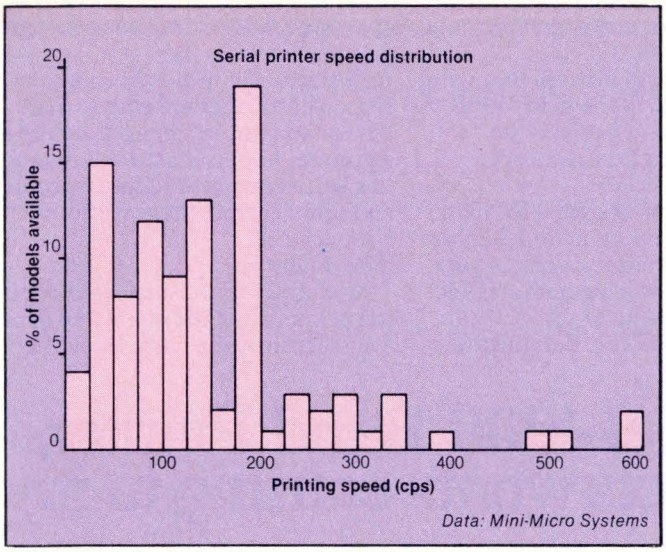
Impact line printer speeds fall into traditional ranges *based around multiples of 300 lpm. The 300-lpm speed is the most popular, followed by 600, 900/1000, 1200 and 1800 lpm. Many speed requirements can be satisfied by band, chain, train and matrix technologies. Expensive drum technology once dominated medium-speed line printers, but band technology is now dominant across most speed ranges.*

This year has been one of fantastic market growth for serial printers and a rather slow year for line printers. Driven by explosive home and business microcomputer markets, sales of impact matrix and solid-font serial printers topped $2 billion, up more than 40 percent from 1981. Impact line-printer sales were sluggish, hampered by economic pressures that affected sales of all high-cost capital goods and forced large OEM customers to defer shipments.

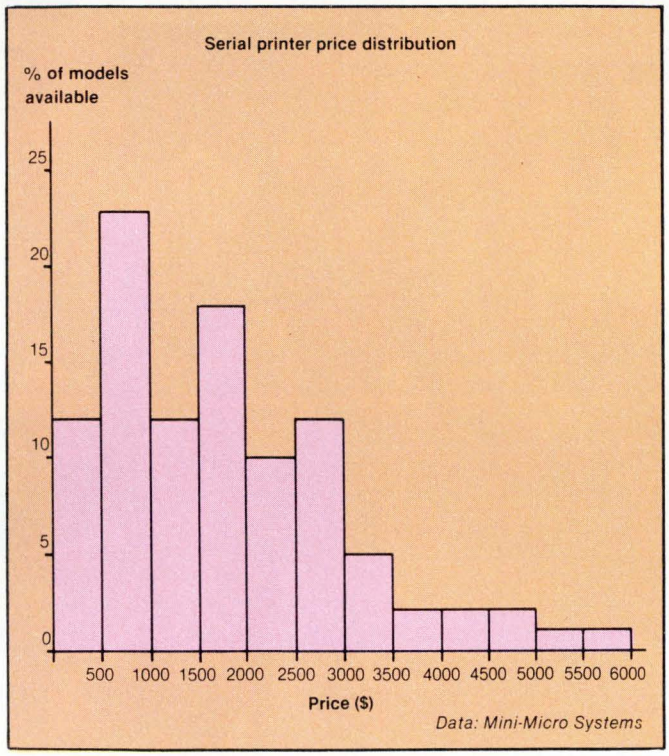
Two microcomputer market demands—low cost and flexibility—were behind the most significant serial-printer developments. Demand for inexpensive letter-quality output inspired a wave of less-than-$2000, letter-quality printers from SCM Corp., Primages, Inc., Computers International, Irwin/Olivetti and NEC Information Systems, Inc., and Dataproducts Corp., Diablo Systems, Inc., and Qume Corp. are said to be eyeing the low-end market.

Demand for microcomputer printer flexibility has led Lear Siegler, Inc., Mannesmann-Tally Corp., Okidata Corp., General Electric Co., Facit, Inc., Integral Data Systems, Inc., Qantex, Santec Corp., Digital Equipment Corp. and others to introduce multi-mode printers that handle data-processing, draft-and near-letter-quality output. The new printers make two, three or even four passes per line of output and use print heads that contain nine, 14, 18 or more wires.

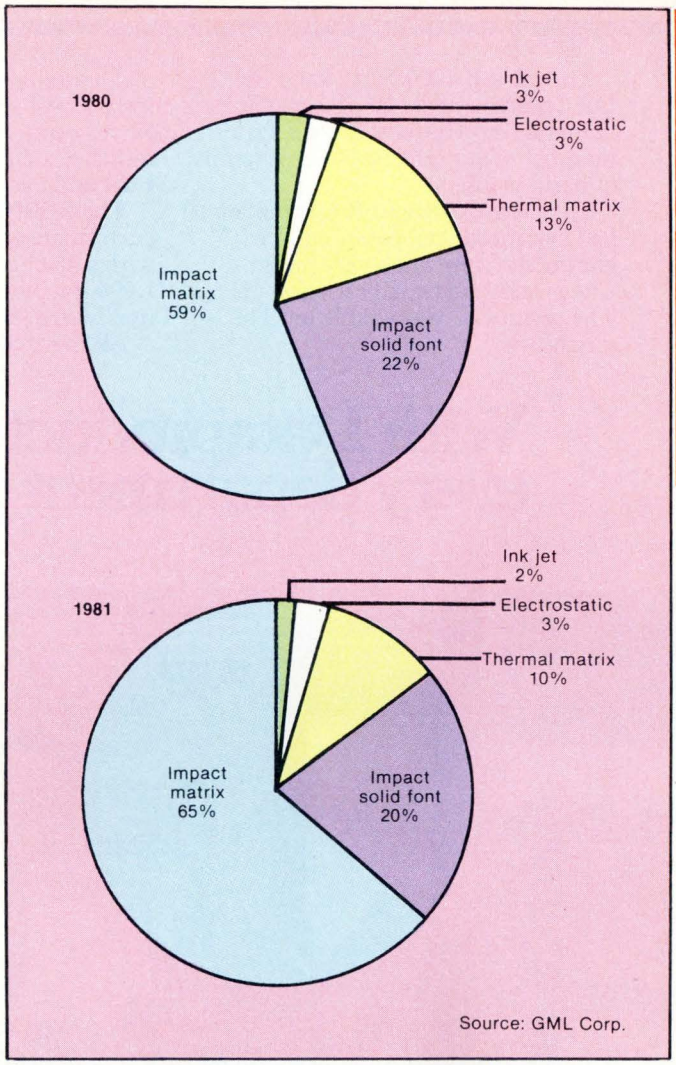
Non-impact serial printer technologies are getting lots of attention at the patent office, but not much more than usual in the market. Thermal mechanisms remain popular in portable and military printers, and ink-jet mechanisms are gaining most popularity in color units



Serial-printer speeds span a 600-cps range *to accommodate a wide variety of applications and price ranges. Solid-font daisy-wheel and thimble printers operate in the 15- to 70-cps range. Single-pass matrix printers operate between 30 and 300 cps, and multipass matrix printers print at many speeds, depending on resolution.*



Serial-printer prices *reflect the fact that microcomputer systems are creating the vast majorty of new serial-printer demand. Versatile microprocessor-based matrix printers are plentiful at less than $1000, and many solid-font, letter-quality printers are now available for less than $2000. As always, serial-printer prices are inversely proportional to speed and resolution.*



Serial-printer technology trends are toward matrix methods and away from solid fonts. *Fully formed character printers generate letter-quality output but print at 75 cps or less. Matrix printers reach 900 cps and generate near-letter-quality output at 50 to 150 cps. Thermal printing is losing popularity in serial printers but gaining interest in teleprinters. Electrostatic methods still suffer from low quality and high paper costs. Ink-jet printing is available in only a few expensive units but holds promise for the future.*

that are better called graphics hard-copy devices than character printers.

The impact line-printer market is dominated by band mechanisms, and the once-preeminent drum line printer has essentially gone out of production. Band printers offer economies and font changeability that other impact line-printer technologies are hard pressed to match. Band-printer speeds range from 300 to 1500 lpm. The fastest impact line printers still use chain/train technology to reach speeds of 2000 lpm or more.

Magnetic, ion-deposition, electrographic and electrophotographic printers once threatened only high-end impact line-printer vendors, but prices for these very fast, inherently flexible machines are dropping quickly and forcing medium- and even low-speed (300-lpm) impact line-printer prices downward. A 300-lpm impact line printer can be had today at an OEM price of less than $6000. Impact line printers will share more of their minicomputer turf with non-impact units in the next few years, and future issues of the *Peripherals Digest* will include non-impact line printers. □

Our new B-1000 helps keep the DP department ahead of a growing demand for printouts. It's the fastest member of our reliable B Series family of band printers.

Like the B-300 and B-600 models, it has Dataproducts' patented Mark V hammer system at its very heart. The system is virtually friction-free. The result is a remarkable level of reliability.

That reliability is proven, too. With over 30,000 units in the field, our B Series printers have become the industry standard for excellence.

Fast and easy.

The B-1000 was designed for high performance, printing up to 1,100 lpm with a 48 character set. It prints out 1,000 lpm with 64 characters and 760 lpm with a 96 character set.

All the B Series were designed with the operator in mind. The long lasting ribbon cartridges are easy to load. The bands can be changed in less than a minute. Sophisticated self diagnostics let the operator identify problems and often correct them without a service call.

The quiet type.

With fully sound-insulated cabinets, the printers operate at only 60 dBA—even less than the noise level of a

With Dataproducts' B-1000™ Band Printer, every department gets what's coming to it.

GREAT MOMEN

typewriter. These cabinets are available on the B-300 and B-600, standard on the B-1000.

A name you can trust.

Dataproducts is the world's largest independent printer manufacturer. For 19 years, we've built printers for the biggest OEMs in the business, putting their names on our machines. These customers make sure our printers live up to some pretty tough standards.

Now our B Series band printers are available with our name on them. Or with your name.

We're here to help.

We have distributors and sales representatives throughout the world.

We'd love to show you how our printers can improve your systems.

Call for more information. Or write our Marketing Department at 6200 Canoga Avenue, Woodland Hills, CA 91365. Telephone: (213) 887-8451.

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TS IN PRINTING

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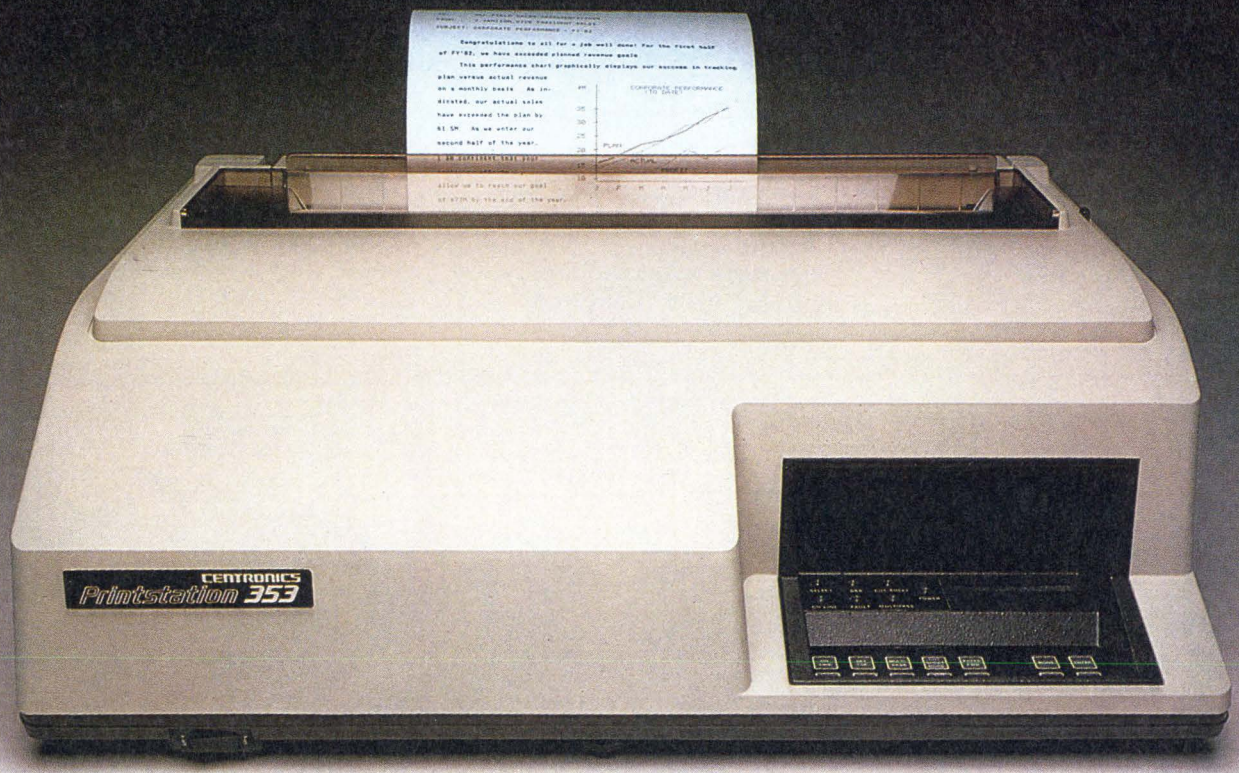
THE PRINTSTATION 350. ITS BEAUTY IS MORE THAN SKIN DEEP.



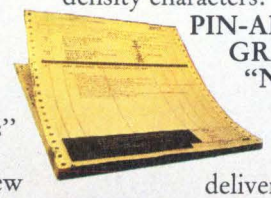
THE MULTIFUNCTION PRINTER WITH UNMATCHED PAPER HANDLING CAPABILITY.

If all you look at is the handsome, office-styled cover you'll miss the real beauty of its functionality, its revolutionary paper handling design and its list of standard features that even competitors' "options" lists can't match.

Centronics' new Printstation 350 is truly the "one-printer solution to the complete range of data processing, business processing, and word processing printing needs".

SEMI-AUTOMATIC PAPER HANDLING... FAN-FOLD, MULTI-PART FORMS, AND CUT SHEET loaded instantly and switched rapidly. In fact the Printstation 350 can be loaded with cut sheets faster and easier than a typewriter.

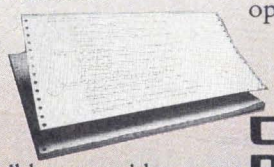
LETTER QUALITY PRINTING, a word processor's dream...using multipass technique for high resolution, high density characters.



PIN-ADDRESSABLE GRAPHICS PLUS "NO-WASTE" DEMAND DOCUMENT REMOVAL deliver true business processing capabilities.

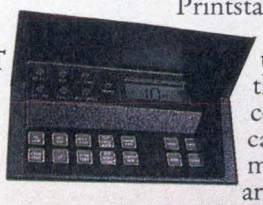
HIGH SPEED "DRAFT" MODE with standard 200 CPS bi-directional logic-seeking feature for data processing operation.

ECONOMY-MINDED, OPERATOR-ORIENTED SERVICE FEATURES. Self-diagnostics are standard. So is the operator-replaceable printhead and the truly "clean hands" snap-in ribbon cartridge.



FAMOUS CENTRONICS BACK-UP. 12 years and 400,000 printers-worth of experience backed up with a world-wide network of factory service locations.

So don't judge a printer by its cover especially when it's one of the Printstation 350 family. Because underneath there's a unique collection of capabilities, mechanical architecture, and electronics that provide a level of versatility we call PRINTSTATION PROCESSING. But if beauty is in the eye of the beholder, you should behold the Printstation 350 in operation. For more information or a demonstration, contact us today.



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CIRCLE NO. 132 ON INQUIRY CARD

PERIPHERALS DIGEST

Selecting a daisy-wheel printer

ERIC C. HOPE, Diablo Systems, Inc.

The OEM should look for a flexible printer with high-quality print from a vendor prepared to meet his needs

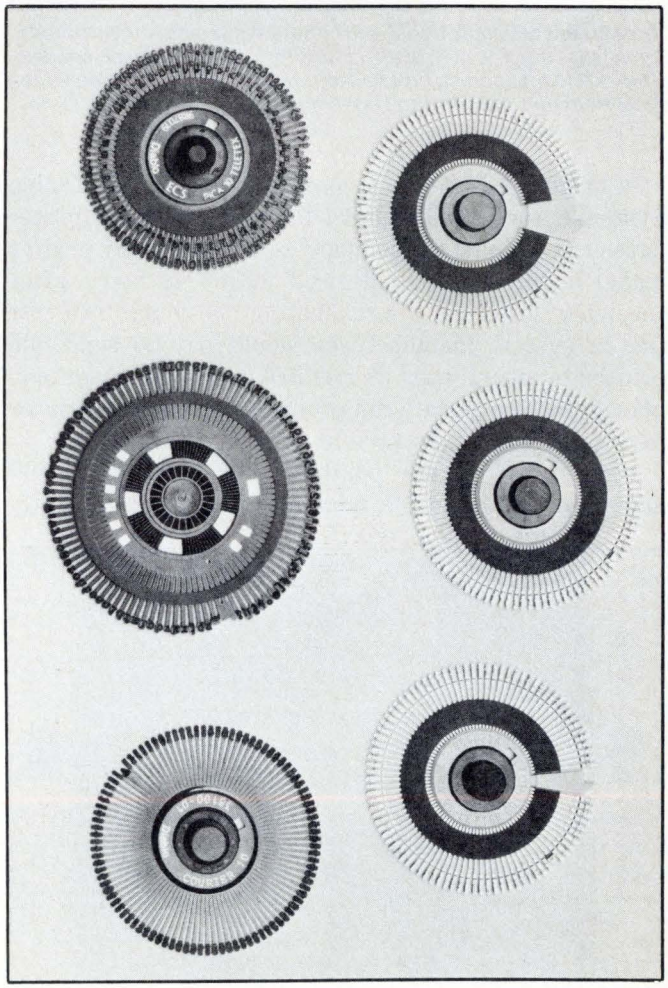
Selecting a daisy-wheel printer involves evaluations that go far beyond a simple assessment of technological features. Today, a buyer must look not only at the printer, but also at some not-so-obvious acquisition costs. These factors are directly related to a printer company's management capabilities and policies, its manufacturing strengths and numerous other organizational structures that stand behind the printer but are not readily visible or frequently considered. After ensuring that a printer vendor can meet an OEM's needs, the OEM can examine the printer's print quality, flexibility and other features to make a decision.

Printer purchasers who do not examine these vendor-related factors face the prospect of unanticipated costs that can quickly outweigh any technological benefits or perceived price advantages that may have motivated the purchase.

Inventory and product maturity

In selecting a daisy-wheel printer that meets a set of technological or price/performance benchmarks, a buyer should look for a supplier that can manage its product inventory. These inventory-management capabilities should extend well beyond the warehousing of printers for small-volume shipments at regular intervals.

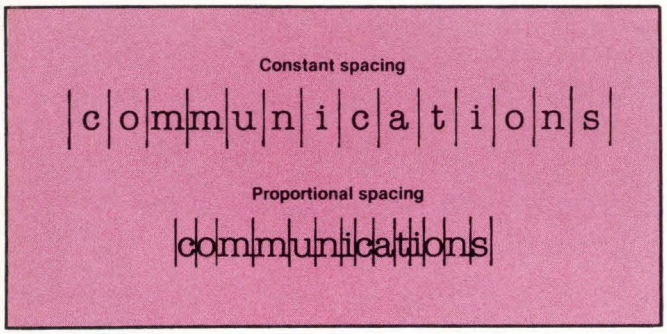
Large manufacturers ship directly to system integrators in moderate volumes for arrival when required. This usually means the printer must be unpacked at the volume purchaser's location, inspected, tested, repacked and then reshipped as an add-on or as part of a total system. The cost of storing the printer, performing the incoming quality assurance and reshipping can be enormous. As a result, large OEMs and other volume



A variety of print wheels *are available for most daisy wheel printers, providing different fonts and character sets. Some manufacturers offer both plastic print wheels, for faster print speed, and metal print wheels, for longer print-wheel life.*

purchasers that look beyond the price tag look into inventory alternatives.

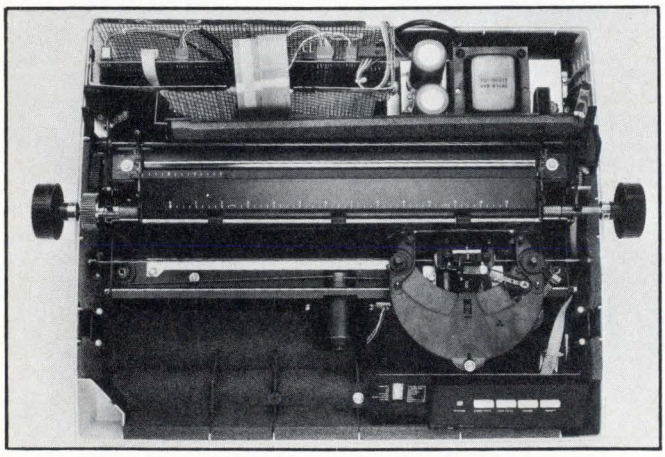
Drop shipments are one such alternative, including not only direct shipments to a system integrator or to regional depot locations, but direct, in single or multiple volumes, to any end-user site in the country. Only printer manufacturers that can show a very high "installability" rate can offer drop shipments. Without an installability rate of 95 percent or more, many end users would receive many inoperative printers.



Comparison of proportional and constant spacing *shows proportional spacing fits narrower characters into narrower spaces, while constant spacing gives all letters a fixed character cell size. Many consider proportional spacing more readable.*

A large investment in computer systems at Diablo Systems, Inc., for example, for drop-shipment procedures has enabled the company to drop-ship any printer model in any quantity desired within 48 hours after receipt of order for approximately one-fourth the cost that a system manufacturer would pay to send one printer to an end user. A credible drop-ship inventory-management program can produce average per-printer savings of more than $100 in shipping costs alone.

Next, the volume purchaser of printers should determine whether the manufacturer can confidently



Inside view of Diablo printer *shows head-positioning mechanism and placement of electronics. Operator panel at bottom right provides controls for form feed, line feed, pause and reset controls, status indicator and DIP switches.*

A supplier's inventory-management capabilities should extend well beyond the warehousing of printers for small-volume shipments.

maintain on-time shipments. A company that plans to ship $30 million in low-cost microcomputer systems over the next 60 days can't afford to delay those sales, even if the printer that is causing the delivery bottleneck is a technological breakthrough. The loss of those revenues over a 60-day period can be enormous with today's high interest rates—as much as $1.8 million, or hundreds of dollars per printer. The system supplier also faces the risk of losing market opportunities, customers and market credibility if a printer causes delayed shipments. To guard against this problem, an OEM should ask to see the printer vendors' manufacturing facilities, and examine build and ship statistics.

A printer's "newness" must also be considered. While a new product might offer better technology and higher quality components, it also presents new manufacturing challenges that take time to be resolved. Every new product follows a "truth curve" in its start-up phase. The truth curve shows that it can take several months for a new product to meet its intended reliability statistics. Lack of production maturity and design maturity, which are functions of cumulative shipments and manufacturing experience (the "learning curve"), often yield MTBF statistics different from design specifications.

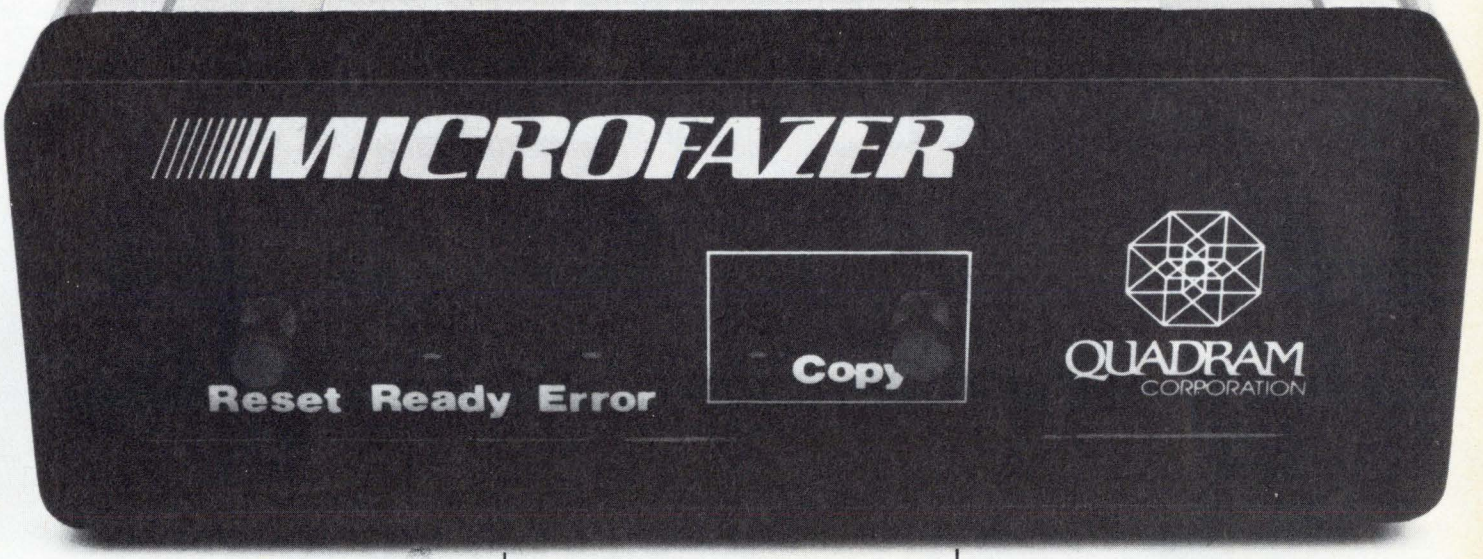
A new printer model should eventually achieve better reliability statistics than an earlier generation model, and many printer buyers are willing to trade temporary reliability shortfalls in return for state-of-the-art technology. The buyer should know, however, the printer's maturity phase so that he can make the purchase knowing what reliability issues a new product may encounter that an older product has long since overcome.

A reliability shortfall in a new or mature product, measured by MTTR, MTBF and duty-cycle specifications, can cause unexpected costs to the buyer. If a printer is expected to provide an MTBF of 2500 hours and the figure proves to be closer to 1000 hours, the purchaser should prepare for more frequent and more costly service expenses.

Spares and the DIF factor

An OEM should be careful not to overlook an opportunity for better profits over the lifetime of a printer from supplies and spares. The retail cost of supplies alone—averaging 0.05¢ to 0.008¢ per printed page—can exceed the purchase price of the printer itself. At typical industry margins of 40 to 50 percent, printer supplies provide an excellent source of major

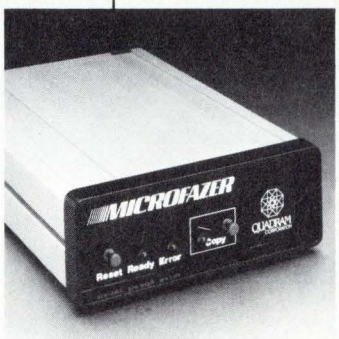
MICROFAZER
THE "ANY COMPUTER ANY PRINTER" BUFFER™

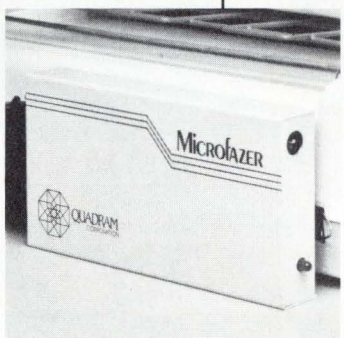


Time is money. You have a computer system because you know that it saves you money by simplifying procedures and reducing time normally involved in your work. Time is an important resource which should not be wasted. You are wasting valuable time if you ever wait for your printer.

No waiting. Now with Microfazer by Quadram there is no more waiting.

Microfazers are inexpensive universal printer buffers which any computer user cannot afford to be without. Any computer—any printer (or plotter!), whether parallel or serial. Microfazer receives information from the computer at ultra high speeds causing the computer to think the printer is printing just as fast as the computer can send. Microfazer holds the information until your printer can handle it, and then sends it on.





More copies. Microfazer is equipped with a copy feature allowing additional copies of the buffered information—from one to as many as you want—with the mere press of a button. When you need your information repeated, for whatever reason, it's always right there—inside Microfazer.

Microfazer™ stack. Microfazer can be stacked with popular modems or other peripherals. Some models can plug directly onto the back of your printer. Install it in less than 60 seconds, and choose the amount of buffer memory you need— 8K, 16K, 32K, or 64K. One model even comes with up to 512K! You may use several Microfazers in series to create just what's right for you. Take data in from a serial computer and out to a parallel printer. Or in from a parallel computer and out to a serial printer. Microfazer is just as flexible as you need it to be.

Low price. Only $169 for 8K of buffering, $189 (16K), $225 (32K) and $299 for a full 64K. Serial-to-Parallel, Parallel-to-Serial and Serial-to-Serial models have slightly higher prices.

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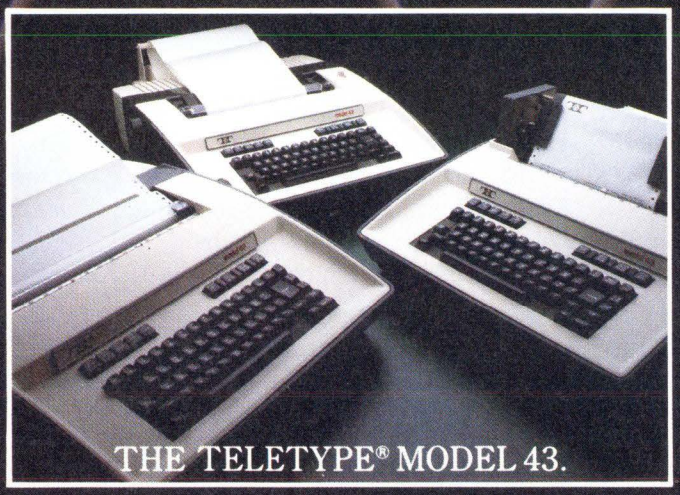
IF YOU THINK A RELIABLE TELEPRINTER FAILS EVERY TWO YEARS,

THINK AGAIN.



THE TELETYPE® MODEL 43.

Imagine an MTBF of over 4½ years. That's the kind of reliability you can expect from the Teletype® model 43KSR, based on current field experience.

Consider how that drives down the cost of ownership. And when you figure the 43's low maintenance and operating costs, it becomes an even better value.

More importantly, the 43 actually goes a long way toward improving system reliability instead of weakening it, as is often expected with a mechanical device.

Reliability begins with features like LSI circuitry which requires fewer moving parts and greatly reduces wear; gold plating over nickel plating on all electrical connections and sockets handling low voltage; injection molding of many components for a precision fit; and custom designed MOS chips.

The 43's value is also highlighted by high quality features like our dot matrix printhead that is capable of delivering more than 200 million characters. You can choose among tractor, pin or friction feeds to suit your needs. And ergonomic features like tactile feedback keyboards improve value by enhancing operator performance.

When you size up reliability, the value of our 43 really shows up.

TELETYPE®: VALUE SETS US APART.

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new revenues. But superior supply revenues are possible only if the printer purchaser selects a manufacturer that can support supply requirements with a full range of supplies that are available when needed.

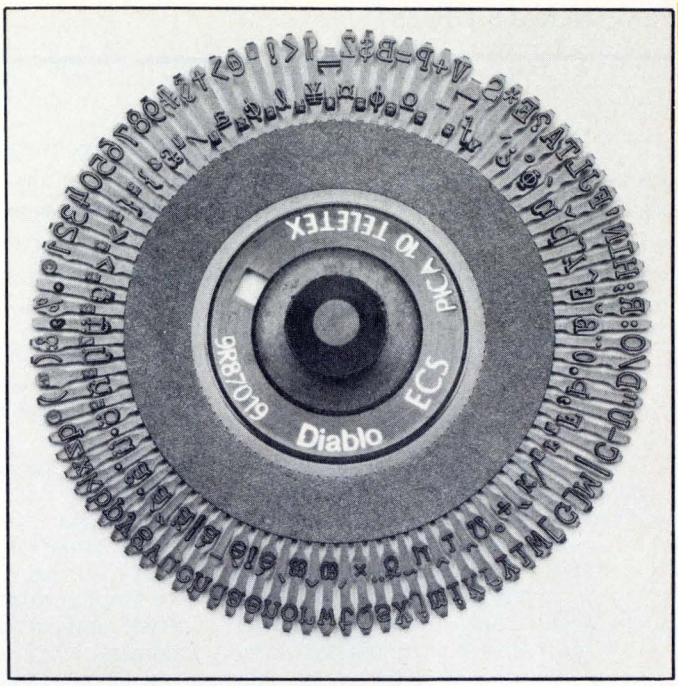
A buyer should consider whether a manufacturer provides just the essentials or a complete line of supplies. The user should not, for example, be forced to live with a limited number of print wheels and ribbon systems.

When a manufacturer of printers also produces spares and supplies, the cost to the buyer for these materials is often reduced. When the OEM buys supplies and spares in volume from a printer manufacturer that in turn has to buy these products from other vendors, the buyer faces another series of markups. The printer buyer should also look for a supplier that can offer refurbished, lower cost spares that carry the same warranty and performance levels of new parts. These spares should be available by overnight mail, driving their price to the OEM even lower. A spares-refurbishment program for electromechanical printer mechanisms can reduce an OEM's spares expenses by 40 percent or more—above and beyond the volume discounts that should be available. Depending on a printer's MTBF over a three-year period, a fully formed-character daisy-wheel printer printing at about 40 cps can consume as much as $300 in spares—if all spares are purchased new.

U.S. computer-system manufacturers derive a greater percentage of overall revenue and profits from European sales. Recognizing the impact of currency exchanges and the regulatory and economic advantages of a European presence, many of these companies have established overseas manufacturing plants. The peripherals industry has not followed this lead as strongly as it might, although the demand for European-manufactured printer peripherals has skyrocketed.

There are at least two major reasons for a strong European peripheral-manufacturing source that should be taken into strong consideration when selecting printers. First, there's the "DIF" factor, meaning duty, insurance and freight. The DIF cost for a standard computer-grade, daisy-wheel printer can be as much as $150. Secondly, with the cost of capital now at 20 to 22 percent, long logistical product lead times are needed for high inventories to support product pipelines of more than 10,000 miles.

By 1984, the only successful daisy-wheel printer companies in Europe will be those that manufacture there. Only in this way will they be able to offer short lead times, lower inventory requirements, products that match European requirements and methods for decreasing DIF-factor expenses and other EEC trade and duty barriers.



Print wheel *comprises "petals" with raised letters. Drop-in print wheels are automatically rotated by the printer to the proper orientation when inserted.*

Print quality and flexibility

While print quality may seem a subjective point, it is crucial (see "Evaluating print quality, p. 240). For a user of a minicomputer or microcomputer, the printer can be the most visible, most-often-handled part of the total system. Users will rate the best computer system poorly if its output devices generate lower than expected quality.

The two most important aspects of print quality are the overall vertical and horizontal alignment and the registration of the printed characters. Deficiencies here are easy to spot. Misaligned characters leap off the page. Unevenly printed characters look as if they were printed on a typewriter with a worn ribbon. Improper shading in a daisy-wheel printer is usually the result of improperly distributed hammer energies and a misalignment or mispositioning of the daisy wheel.

The printer should also be capable of proportional-spaced printing, meaning that it can place letters closer together or farther apart, depending on the width of characters. Descenders and ascenders should extend below and above the base line in a consistent, easily readable fashion.

As systems become more capable and applications become more flexible, so do printers. Buying a single-purpose, inflexible printer can be a serious error leading to early system obsolescence.

Given an end user's demand for efficient, all-purpose systems and peripherals, a printer that can handle multiple chores is the best choice. An engineer at a multinational corporation, for example, may want a system to help generate English and foreign-text

letters and memos, do spread-sheet analysis involving limited charts and graphs, complete and print multipart forms and write reports with footnotes. The same system may be shared with the company's legal department, requiring a printer with a variety of fonts and pitches as well as high-quality text. So, just as systems are becoming multipurpose—most small-business microcomputer systems today spend 60 percent of their time performing word processing and 40 percent performing data processing—printers must evolve to meet this all-purpose trend.

If an OEM selects a daisy-wheel printer that can do little more than print one page at a time, one copy at a time, in two or three different fonts only and at a limited number of pitches, the OEM will have to buy and stock other printers to meet unique needs. On the other

EVALUATING PRINT QUALITY

Print quality shouldn't be left to a subjective judgment by printer purchasers. There are specific standards of measurement, involving overall readability, general appearance, aesthetics, character location control and character clarity. Knowing what to look for, helps OEMs understand why some printers receive better end-user acceptance.

Relative character placement

To remove some of the subjectiveness in text-quality evaluation, a seven-element scale evaluates a printer's ability to locate characters in the right places relative to other characters. The seven elements are:

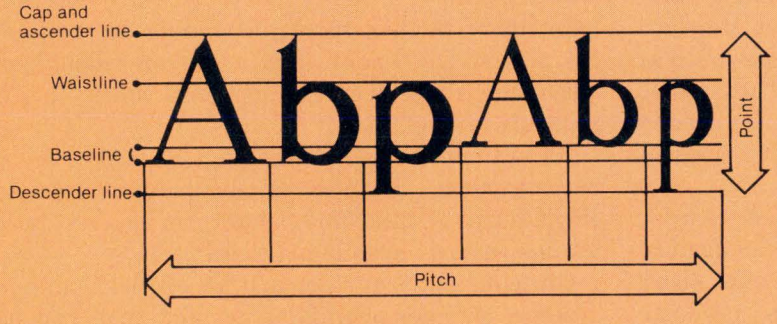
- **Pitch:** the measurement of horizontal character placement, usually measured in 1/72-in. increments. Users who insert a 10-pitch wheel for certain applications, for example, want their characters to remain consistently at that pitch throughout an entire document. This is one of the most noticeable textual deficiencies when not carefully controlled.
- **Point:** the vertical measurement of a character from the capital/ascender line to the lowest descender line. One point equals 0.011 in. When point control is missing, horizontal lines of print begin to roll awkwardly up and down like a roller coaster across the page. Few print-quality factors can contribute as quickly to negative perceptions of text, and a casual observer can spot even a slight deviance.
- **Capital and ascender line:** the upper vertical point of a printed character that extends above the "waistline." The cap and ascender line for capitals should not be above the top of lower-case letters with above-waistline stems, such as the lower case "b".
- **Waistline:** usually 60 percent of the distance from the baseline to the cap on the ascender line, represented by the upper vertical points of the round parts of a lower case "b," "p," "c" and "e."
- **Baseline:** the lower vertical point of a character that does not extend to the descender line. The upper-case characters "A," "B" and "C" should all sit squarely on the baseline.
- **Descender line:** the lower vertical point for all characters that extend beyond the baseline. The lower-case characters "p," "q" and "y" all extend below the baseline to the descender line.
- **Proportional spacing:** spacing used to enhance the aesthetics of a printed page through the balancing of black and white areas. Proportional spacing requires variable unit values instead of a fixed pitch. Proportionally spaced words generally have characters that run closer together. When text is not proportionally spaced, each character—whether it is wide, such as "w," or thin, such as "i"—fits within a consistent but sometimes awkwardly identical "cell" area, even if that cell is two or three times larger than necessary. In proportionally spaced text, cell widths vary, allowing an "i," for example, to move closer to, say, a "t," taking up only as much room as it needs to remain legible. Proportionally-spaced text is more readable.

Individual character clarity

The seven elements in the previous scale relate to a character's relationship to other characters or to the character's placement within an acceptable placement grid. Another set of quality factors relates specifically to each character's own "personality," or clarity. The six general tests for print quality clarity are:

- **Dimension:** the character should have the right size, depth and width.
- **Density:** the character should not be too dark or too light, nor vary in density from top to bottom.
- **Contrast:** the character's blackness should provide good readability.
- **Distinctness:** the character should be sharp and clear. Fuzzy printing can result from ink spreads and smears caused by uncontrolled impact or improper hammer energies.
- **Resolution relationships:** the character's individual distinctness should be consistent with that of other characters at different distances and varying spatial frequencies.
- **Uniformity:** the image should be uniformly dense, without reflectability or graininess.

Print quality may be in the eye of the beholder, but by examining output from a variety of printers on the basis of such predefined qualities as those outlined in these scales, an OEM can see textual faults that can soften system sales.



Print placement evaluation guide *indicates proper relative location of the different parts of each letter.*

Anadex SILENT SCRIBE™ printers. Quietly going about your business.

Now and then office noise levels can go sky-high. But with Silent/Scribe – our new family of matrix impact printers – you can raise your printer expectations while significantly lowering your office noise level.

How quiet is "silent"? Silent/Scribe operates at less than 55 dBA, which means that in the average office you may have to look at it to determine whether it's printing.

SILENT/SCRIBE MODELS

Standard Features	Char. per Inch	DP-9000A	DP-9500A	DP-9001A	DP-9501A	DP-9620A
Printing Speed (Char. per Sec.)	10	150	150	120	120	200
	12	180	180	—	—	120
	12.5	—	—	150	150	—
	13.3	200	200	—	—	—
	15	—	—	180	180	150
	16.4	—	—	200	200	164
Enhanced	10	—	—	—	—	100
Expanded Print (Double Width)		Yes	Yes	Yes	Yes	Yes
Dot Addressable Graphics (Dot/In., H/V)		60/72	60/72	75/72	75/72	72/72
Max. Line Width (In.)		8.0	13.2	8.0	13.2	13.2
Audible Alarm		Opt.	Opt.	Opt.	Opt.	Yes
Out-of-Paper Sense		Yes	Yes	Yes	Yes	Yes
Ribbon, Continuous Loop Cartridge (Yds)		30	30	30	30	30
Interfacing: Parallel Cent. Comp.		Yes	Yes	Yes	Yes	Yes
RS-232-C Serial		Yes	Yes	Yes	Yes	Yes

And Silent/Scribe is as easy to buy as it is to live with. You can select a variety of printing speeds, fonts and line widths. Some models provide both draft and enhanced quality copy. All models have superb dot-addressable graphics at no extra cost.

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CIRCLE NO. 135 ON INQUIRY CARD

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hand, a printer with accessory options such as sheet and forms handlers, firmware that offers word- or data-processing features and hundreds of fonts at numerous pitches puts the OEM in a position to increase system sales as applications become identified among special users or within large companies.

Diablo, for example, can produce traditional 96-character daisy wheels for special applications within eight to 12 weeks. The company also offers a 400-character-plus, extended-character-set daisy wheel, holding as many as 192 fully formed characters from which additional alphanumerics can be constructed. With this type of daisy wheel, a user can do complex engineering or mathematical equations and then write a report about the equations in some 33 European languages without changing the print wheel.

Buying a single-purpose, inflexible printer can be a serious error, leading to early system obsolescence.

Daisy-wheel manufacturers have been working to improve the hardware, software and human interfaces between users and the daisy-wheel elements. Changing print wheels can be a time-consuming task, and often results in print-element damage. Cartridge and drop-in print wheels help simplify the chore. Diablo's model 620 drop-in plastic print wheels slip into a metal envelope in which they automatically position themselves and perform self-homing. The drop-in wheels contain encoded information detailing their font and pitch. This encoded information can be read by the host computer to ensure that a user hasn't inserted the wrong print wheel, a common occurrence that can lead to ruined print wheels and unacceptable text or numeric output.

Other features

There are a number of features a system integrator can look for in a printer to keep competitive. These include interfaces, intelligence and regulatory standards.

It isn't enough anymore for a printer to provide just one major industry interface. Printers should offer the major standards as well as the flexibility to interface to others. If not, the system integrator may have to stock several printers from several manufacturers. The system integrator should instead look for a printer that, through minor adaptation, can interface with practically any type of system. This way, as a system product evolves, the printer inventory can evolve with it.

As the printer industry has grown, so have de facto standards. Major manufacturers realize, therefore, that their printer business won't survive on the basis of offering just a serial interface with everything. A parallel interface won't meet everyone's needs. The IEEE-488 interface alone isn't enough. But the costs associated with offering every interface with every printer are enormous. Diablo's all-purpose interface, for example, can automatically emulate any of three popular interfaces used most often with 8-bit microcomputer systems, requiring nothing more than a cable to change an interface.

With built-in standard buffers, intelligent printers can accept data transmission at off-peak periods, saving hundreds of dollars in line costs.

All peripherals are gaining intelligence, and printers are no exception. Intelligence isn't very difficult to add or expensive to offer, and it makes a major difference in a user's perception of the printer.

Intelligence makes the printer more application flexible, user friendly and capable. With built-in standard buffers, an intelligent printer can accept data transmission at off-peak periods, saving hundreds of dollars in line costs. They can also offer self-diagnostics, allowing the end user either to fix the printer himself, or tell a service representative in advance what is wrong with it.

Firmware can hold special application programs for special tasks. Word-processing firmware can automatically off-load system functions such as text centering, proportional spacing, shadow printing, subscript and superscript generation, boldface printing and underlining. This leaves more system power for other tasks.

An OEM should make sure that a printer meets applicable regulatory standards. Without regulatory approvals, a system can be barred from a European country. Without FCC approvals, systems can't be sold to consumers for home computing. A printer that doesn't provide electrostatic discharge immunity can present a safety hazard or require maintenance calls. Printers should be built to accept standard accessories internally, rather than rely on outside "stunt" boxes for accessory attachments.

A printer should have the flexibility to accept add-on cards or other features to maintain a competitive edge or to serve a customer niche. The supplier should be able to accommodate the OEM's requests, especially if the OEM's name is on the printer. □

Eric C. Hope is vice-president of marketing at Diablo Systems, Inc., Hayward, Calif.

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SOLID FONT SERIAL PRINTERS

Company Model	Printing method	Printing speed (cps)	Chars./line	Graphics (Y/N)	Multi-color (Y/N)	Multi-pass (Y/N)	Price	Specify fonts
ANDERSON JACOBSON, INC.								
AJ 833	Daisywheel	45	132/158	N	N	N	$3650	Interchangeable
APPLE COMPUTER								
Letter Quality	Daisywheel	40		Y	N	N	$2195	Prestige Elite 12, Gothic 15, Courier, bold
C. ITOH ELECTRONICS, INC.								
F10-40	Daisywheel	40	136/163	Y	N	N	$1995	
F10-55	Daisywheel	55	136/163	Y	Y	N	$2400	
COMPUTER INTERNATIONAL								
Daisywriter 1500	Daisywheel	16	80/264	Y	N	N	$760 (Q100)	12 fonts, 15 languages
CONTROL DATA CORP.								
Certainty 410	Daisywheel	55	132	N	N	N	2775, Q5	many printwheels
DATA TERMINALS & COMMUNICATIONS								
DTC-380Z	Daisywheel	32	132/198	N	N	N	1199	12 fonts, 15 languages
DTC-383RO	Daisywheel	40	132/198	N	N	N	3295	more than 150
DATAPRODUCTS CORP.								
DP-35	Daisywheel	35	132/196	Y	Y	N	$1266 (Q100)	More than 100 plastic or metal print wheels
DP-55	Daisywheel	55	132/196	Y	Y	N	$1426 (Q100)	More than 100 plastic or metal print wheels
DIABLO SYSTEMS, INC.								
620	Daisywheel	25	132/197	Y	N	N	—	More than 200 wheels
630	Daisywheel	40	132/197	Y	N	N	—	10, 12, 15 pitch; more than 200 wheels
630 ECS	Daisywheel	40	132/197	Y	N		—	More than 200 wheels
DIGITAL EQUIPMENT CORP.								
LQPO2	Daisywheel	32	158	N	N	N	$2800	Daisywheels
FACIT/DATAROYAL								
4560	Daisywheel	22		N	N	N	$1395	Uses 105-, 122-character daisywheels
4565	Daisywheel	40	136	N	N	N	$1895	
HARRIS								
8730	Daisywheel	35	132	N	N	N	3790	96 ASCII
8735	Daisywheel	35	132	N	N	N	4050	96 ASCII
8750	Daisywheel	55	132	N	N	N	4690	96 ASCII
HEWLETT-PACKARD CO.								
HP2601A	Daisywheel	40	132/158	N	N	N	$3950	Various 96-character daisywheels
HP2602A	Daisywheel	25	132/158	N	N	N	—	Various 96-character printwheels
IRWIN/OLIVETTI, INC.								
DY250	Daisywheel	25	80/198	Y	N	N	—	33 types

SOLID FONT SERIAL PRINTERS

Company Model	Printing method	Printing speed (cps)	Chars./ line	Graphics (Y/N)	Multi-color (Y/N)	Multi-pass (Y/N)	Price	Specify fonts
DY211	Daisywheel	20	80/198	N	N	N	$995 (Q500)	33 types
DY311 MI	Daisywheel	32	80/225	Y	N	N	$1290 (Q500)	33 types
NEC INFORMATION SYSTEMS, INC.								
3510/15/20/25	Thimble	35		Y	N	N	$3200	More than 50
7710/15/20/25	Thimble	55		Y	N	N	$2300	More than 50
OMEGA NORTHWEST, INC.								
Transtar 140	Daisywheel	40	132/158	N	N	N	1695	many printwheels
PRIMAGES, INC.								
Image I	Daisywheel	45			N	N	1650	100-spoke daisywheels
PRINTER SYSTEMS CORP.								
PSC-D50	Daisywheel	50	132/196	Y	N	N	2572	choice of more than 100
PSC-N3500	Daisywheel	33	136/163	Y	N	N	2100	choice of more than 100
PSC-N7700	Daisywheel	55	136/163	Y	N	N	2925	choice of more than 100
QUME CORP.								
Sprint 9/45	Daisywheel	45	132	Y	N	N	2250	more than 100 printwheels
Sprint 9/55	Daisywheel	55	132	Y	N	N	2630	more than 100 printwheels
Sprint 10/35	Daisywheel	35	132	Y	N	N	1695	more than 100 printwheels
Sprint 11/40	Daisywheel	40	132	Y	N	N	1776	more than 100 printwheels
Sprint 11/55	Daisywheel	55	132	Y	N	N	1990	more than 100 printwheels
Sprint 11/45 Widetrack	Daisywheel	45	196	Y	N	N	2695	more than 100 printwheels
Sprint 11/55 Widetrack	Daisywheel	55	196	Y	N	N	2815	more than 100 printwheels
RADIO SHACK								
DWII	Daisywheel	43	136/163	N	N	N	1995	many 124-char. wheels
DWP-410	Daisywheel	25	136/163	N	N	N	1495	many 124-char. wheels
RICOH								
1300	Daisywheel	30	163	N	N	N	800	20 printwheels
1600	Daisywheel	50	163	N	N	N	1175	20 printwheels
SMITH CORONA								
TP-1	Daisywheel	12	105	N	N	N	895	pica, regency, judicial, tempo
WANG LABORATORIES								
6581W	Daisywheel	35	198	N	N	N	$6000	10, 12, 15 pitch; proportional printwheels
6581WC	Daisywheel	35	270	N	N	N	$7000	10, 12, 15 pitch; proportional printwheels
DW-20	Daisywheel	20	198	N	N	N	$2695	10, 12, 15 pitch; proportional printwheels

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CIRCLE NO. 137 ON INQUIRY CARD

Selecting a serial matrix printer

MARK TAKEUCHI, ROBERT COWAN and JACK HERMANSON, C. Itoh Electronics

The right printer must fit the application, the system and the user's expectations

The quality of the hard copy coming out of a computer system is the direct result of the planning put into the system. Selecting the right combination of hardware, software and printer involves matching capabilities to requirements and expectations.

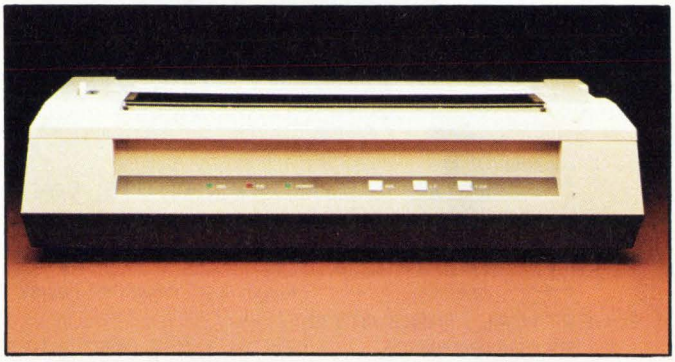
Choosing the right printer requires a user to work in reverse, starting with determining what is to be printed; assembling a want-need list based on the printer's technology, performance and price; and examining the computer system and its applications.

Establishing priorities

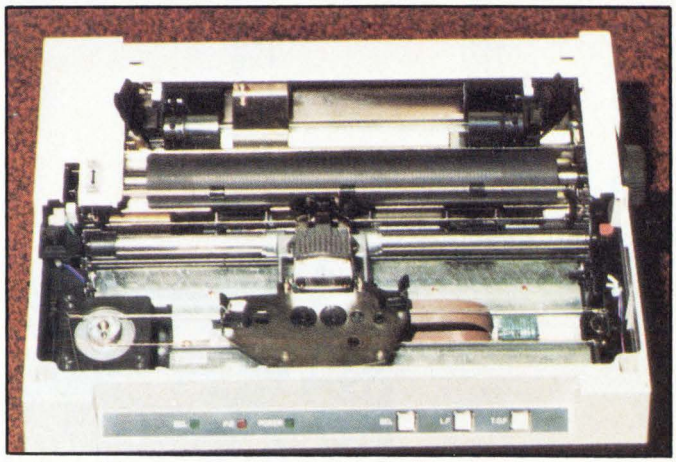
The first step in selecting a printer is to establish user priorities: the expected types of output required, essential features, desirable features and price. These considerations can be organized into a want-need list (p. 251). The list can be divided into three sections: features and price, printer technology and immediate and long-term requirements.

Features include both software-directed capabilities and those provided by a printer's design. Software features support data-processing, word-processing (near-letter-quality or letter-quality), graphics and business-forms-printing applications. A user should order these features according to both immediate and projected importance and, if possible, the anticipated percentage of total printer use each feature performs. The printer's hardware design determines character spacing and line length, type of paper required, incremental printing, descenders/ascenders and, in more advanced printers, margin setting, underlining, proportional spacing and tabbing.

Most dot-matrix printers support some graphics. But the term "graphics capabilities" leaves unclear such parameters as resolution and dot density, paper type and the number of copies possible. In addition, graphics applications such as line/bar charts, maps and designs must be defined.



C. Itoh 1550 dot-matrix printer *has the low profile typical of current products. Forms control and LED display are easily accessible on the front panel.*



C. Itoh printer *houses components found in most matrix printers.*

Printer price is related not only to a printer's capabilities but to its technology. It is common to spend 15 to 20 percent of a microcomputer system's price for a printer. However, a user should not let this guideline limit the printer budget, and should consider future as well as current applications, adding 5 to 10 percent for these future uses. Thus, a $3000 to $5000 total budget for a personal computer or small-business microcom-

```
1.DOT MATRIX PRINTER
2.PRINT SPEED          120 CPS, 63 LPM  (LOGICAL SEEKING)
3.DOT CONFIGURATION    (1)CHARACTERS    7 X 9
            (W X H)    (2)CHARACTER GEN. GRAPHIC    8 X 8
                       (3)DOT GRAPHIC  1280 X 8 (MAX/LINE)
4.CHARACTER SIZE & FONT
  PICA (10 CPI)      THE QUICK BROWN FOX JUMPS OVER A LAZY DOG.
  PICA (EXPANDED 5 CPI)
  ELITE (12 CPI)     THE QUICK BROWN FOX JUMPS OVER A LAZY DOG.
  ELITE (EXPANDED 6 CPI)
  PROPORTIONAL (PROP. SPACE)   THE QUICK BROWN FOX JUMPS OVER A LAZY DOG.
  PROPORTIONAL (EXPANDED)
  CONDENSE (17 CPI)    THE QUICK BROWN FOX JUMPS OVER A LAZY DOG.
  CONDENSE (EXPANDED 8.5 CPI)
                       EACH CHARACTER CHANGEABLE within One LINE
5.CHARACTERS
  (1)ALPHA-NUMERICS
      !"#$%&'()*+,-./0123456789:;<=>?
     @ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
  (2)JAPANESE HIRAGANA OR GREEK
     αβγδεζηθικλμνξοπρστυφχψω⊿ΓΣΛΩ↑↓←→±≠≥≤≈・⊕∞∴½¼0123456789()+-・*/
  (3)JAPANESE KATAKANA
     。「」、・ヲァィゥェォャュョッーアイウエオカキクケコサシスセソタチツテトナニヌネノハヒフヘホマミムメモヤユヨラリルレロワン゛゜
  (4)CHARACTER GENERATOR GRAPHIC
     ▁▂▃▄▅▆▇ ▌▐▀▄▬▭┼╪┤├┬┴┌┐└┘ ∩∪=╫╪▲▼♠♥♦♣●○／＼╳┈┆╌┤├┄
6.UNDERSCORE
    THE M8510A DOT MATRIX PRINTER CAN ADD UNDERSCORE.
7.EMPHASIZED PRINTING
    THE M8510A DOT MATRIX PRINTER CAN EMPHASIZE CHARACTERS.
8.HOLIZONTAL TABULATION
    PROGRAMMABLE     (MAX 16 POSITIONS)
9.VERTICAL TABULATION
    PROGRAMMABLE     (EACH LINE SETTABLE / MAX 6 CHANNELS)
10.REVERSE LINEFEED AVAILABLE
11.VARIABLE LINE SPACING
    (1) 1/6 INCH   (2) 1/8 INCH   (3) n/144 INCH
        1/6            1/8            1/144 2/144 3/144 4/144 5/144 10/144 25/144
        1/6            1/8                                                  ETC..
        1/6            1/8
        1/6            1/8
        1/6            1/8
        1/6
12.LEFT MARGIN PROGRAMMABLE
13.INCREMENTAL        MODE
                PRINT       AVAILABLE
14.DOT GRAPHICS
```

CI C. Itoh & Co., Ltd.

Print sample from C. Itoh M8510A matrix printer *shows different type styles, type formats and graphics capabilities possible with many matrix printers.*

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MEDIUM SPEED IMPACT DOT MATRIX 132 COLUMN R.O. PRINTERS

Manufacturers Model No.	List Price	Print Speed CPS	Matrix Character	Size of Buffer	Noise	Dot Graphic D.P.I.
Hi-G 9/132PS Durawriter	$1395.00	150	9 x 9	3,422	58dbA	72 x 72
		75	18 x 9			
Texas Instruments 810	$1895.00	150	9 x 7	256 to 2,048*	72dbA	72 x 60 Optional $600.00
DataSouth DS-180	$1595.00	180	9 x 7	2,000	68dbA	75 x 72
DataRoyal 5000C	$1695.00	165	9 x 9	512 to 2,048*	68dbA	72 x 72 Optional $100.00
Okidata ML-84	$1495.00	200	9 x 9	2,048	72dbA	72 x 72
		50	13 x 17			144 x 144

NOTE: Chart based on manufacturer's information available as of October 1, 1982
*Optional @ extra cost

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CIRCLE NO. 139 ON INQUIRY CARD

puter system might indicate a printer investment of approximately $600 to $1250.

Even microsystem users that have decided on dot-matrix technology should become familiar with alternate technologies, such as daisy wheel, thermal and ink jet.

Daisy-wheel technology combines excellent word-processing capabilities with low-speed printing and cumbersome or nonexistent graphics capabilities. Thermal printers, while quieter, require specially treated

It is common to spend 15 to 20 percent of a microcomputer system's price for a printer.

Printer want-need list

This list can help users identify printer features that should be considered before selecting a printer.

I. COST

Printer: $ _____

System: $ _____

Percentage of printer cost to total system cost: _____% (typically 20–25% of system cost)

II. TECHNOLOGY: (daisy wheel, serial or line-impact matrix, thermal or ink jet) _____

III. APPLICATION	**Immediate need**	**% of use**	**Long-term need**	**% of use**
1. Word processing				
Correspondence	☐	_____	☐	_____
NLQ	☐	_____	☐	_____
LQ	☐	_____	☐	_____
2. Graphics				
Dot-addressable graphics	☐	_____	☐	_____
Line/bar charts	☐	_____	☐	_____
Pictures/maps	☐	_____	☐	_____
3. Forms				
Pre-printed	☐	_____	☐	_____
Original	☐	_____	☐	_____
Multi-part forms	☐	_____	☐	_____
Number	_____		_____	
4. Data processing/assembly		_____		_____

IV. FEATURES

1. Speed (cps): _____
2. Resolution: _____
3. Paper width:
   - Variable: _____
   - Maximum: _____
4. Print line: _____
5. Paper feed:
   - Pressure: ☐ ☐
   - Tractor: ☐ ☐
   - Bidirectional: ☐ ☐
6. Interchangeable fonts
   - Pica (10 cpi) ☐ ☐
   - Elite (12 cpi) ☐ ☐
   - Proportional spacing ☐ ☐
   - Mixed-font/same-print line ☐ ☐
7. Double-width printing ☐ ☐
8. Compressed printing ☐ ☐
9. Forms compatibility ☐ ☐
10. True ascenders/descenders ☐ ☐

paper, resulting in increased paper costs. Ink-jet printers also print matrix characters, but are generally more expensive than impact matrix and daisy-wheel devices.

Technologies differ in flexibility, speed and resolution. Line matrix technology, for example, generally offers higher speeds than does serial matrix technology. This line-printer advantage is offset by the significantly higher price of line matrix technology, especially when compared to the cost of microcomputer systems. Typical microcomputer user requirements call for a well-balanced proportion of speed and resolution. Within these technology guidelines, serial matrix printers offer speeds higher than 100 cps, with a lower resolution for data-processing operations and, at lower speeds, increased dot densities for better resolution. This increased resolution can be accomplished by a multipass print mode or by using a head with multiple stacks of wires.

Many printer suppliers provide a choice of protocols and options through DIP switches or similar devices.

A user should choose a printer with both short- and long-term goals in mind. For example, a printer's primary use may initially be for word processing of internal memos, with only limited graphics applications. But the graphics/word-processing mix might change, and a substantial number of bar and pie charts may become a requirement.

System compatibility and applications

After priorities have been established and alternative technologies have been explored, a prospective purchaser should look at a system's environment, focusing on software support and printer/system interfacing.

Interfacing should never be taken for granted. Most systems specify printer interfaces, limiting a user's choice of printer. Likewise, some printers offer only one or two interfaces, and are compatible with only a limited number of systems.

The most common microcomputer interface specifications are the 8-bit parallel (Centronics-compatible) and RS232C (bit serial) standards. Protocol elements such as X-ON/X-OFF, ETX/ACK and DC1/DC3 are often included. Many printer suppliers include a choice of protocols and options through the use of DIP switches or similar devices. If the desired printer and the user's system don't support a common interface, it must be determined whether a custom interface is worth its development costs.

Printers and application mix

Every printer is designed to fit categories of end-user wants and needs. Printers that are otherwise similar might differ in dot densities or graphic capabilities. A user must decide whether each feature is worth an additional price.

For example, in microcomputer applications, an 80-column width and an 8-in. print line are typically sufficient. But in more sophisticated applications requiring tabular printout on 15-in.-wide paper, print-line width would be higher on the want-need list.

Also high on most users' want-need lists are paper-feed capabilities. Tractor or pin feed permits the use of punched paper for correct alignment. With a rear-mounted tractor, printing can be accomplished close to the paper tear-off, an important feature for paper saving and forms control. A front-mounted tractor, while not as versatile as the rear tractor, is more common and easier to adapt to an installed printer. A pressure-feed mechanism allows the use of any paper, a requirement for many business-correspondence applications, but one that can lead to alignment difficulties. Some printers provide switch-selectable pressure- and tractor-feed mechanisms.

The introduction of a new printer finds greater success if both supplier and OEM are aware of future user needs and evolving applications. Users ultimately force suppliers, OEMs and others in the supply chain to respond to user needs. The most responsive OEMs lead the market.

Users currently demand graphics, high-quality printing, maintenance-free operation and excellent documentation. OEMs and suppliers have accurately reacted to these demands, with worldwide monthly shipments of printers approaching 100,000 units. □

Mark Takeuchi is president, **Robert Cowan** is vice president and **Jack Hermanson** is regional sales manager at C. Itoh Electronics, Los Angeles.

NEXT MONTH IN MMS

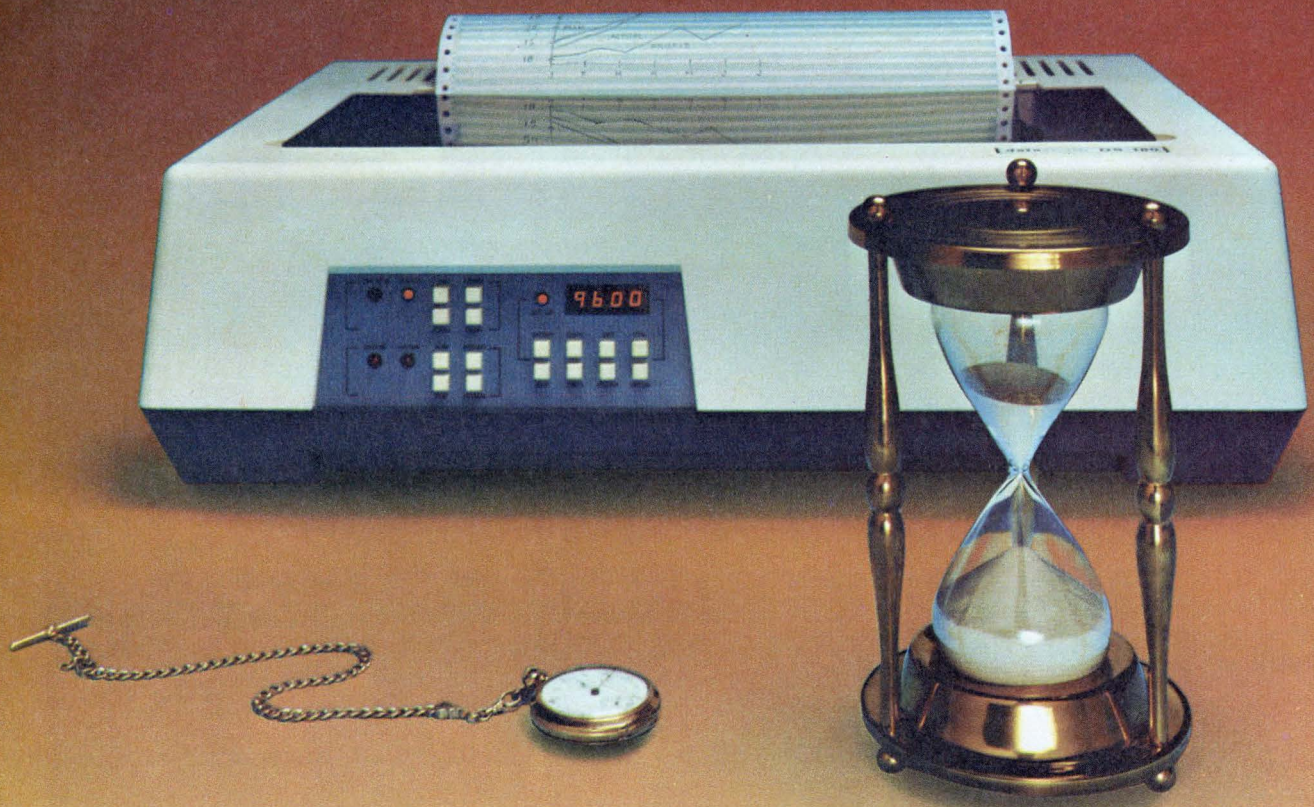
The December feature package consists of feature articles of the various technologies significant to Mini-Micro Systems' unique readership of value-adding integrators and resellers.

Topics will cover:

- voice synthesis and recognition.
- computer graphics
- the automated factory
- the electronic office
- semiconductor memory

CIRCLE NO. 141 ON INQUIRY CARD →

TIME-PROVEN PERFORMANCE



While new printers with impressive specifications are introduced on an almost daily basis, only time will tell the true quality of the product. Over the past 2 years our customers have continued to buy the DS180 printer, not only because of its impressive performance and competitive price, but also because of our outstanding track record for product reliability and customer support.

We have continually improved on the performance of the DS180 by incorporating such enhancements as dot addressable graphics, 6 user-selectable print sizes and a 2000 character buffer. These features coupled with 180 cps printing, parallel and serial interfaces, adjustable tractor feed and over 40 other programmable features, make the DS180 one of the most versatile matrix printers available today.

Before you select your next printer, why not take a look at a time-proven performer—the Datasouth DS180.

The DS180 printer is available nationwide through our network of sales/service distributors.

datasouth computer corporation

P.O. Box 240947 • Charlotte, NC 28224 • 704/523-8500
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MATRIX SERIAL PRINTERS

Company Model	Printing method	Printing speed (cps)	Chars./ line	Graphics (Y/N)	Multi-color (Y/N)	Multi-pass (Y/N)	Unit price ($)	Specify fonts
ADDMASTER CORP.								
171	7 x 7 impact	150	20	N	N	N	299	
181	7 x 7 impact	150	40	N	N	N	399	
ALPHACOM, INC.								
Alphacom 20	thermal	36	20	Y			175	ASCII
Alphacom 40	thermal	160	40	Y			295	ASCII
Alphacom 42	thermal	80	40	Y			220	ASCII
AMPEREX ELECTRONICS CORP.								
GP300	9 x 9 impact	300	132	Y	N	N	3165	Standard Data, Gothic, others
ANACOM								
150	9 x 9 impact	150	80/136	N	N	N	1495	alternate available
150Z	9 x 12 impact	150	85/132	Y	N	Y	1895	ASCII, graphics, italics, download aisle
160	9 x 9 impact	150	80/136	N	N	N	1750	
160Z	9 x 12 impact	150	85/132	Y	N	Y	2150	English, graphics, italics, downloadable
ANADEX, INC.								
DP-9000A	9 x 9 impact	200	80/106	Y	N	N	1625	10, 12, 13.3 cpi
DP-9001A	11 x 9 impact	200	80/133	Y	N	N	1625	10, 12.5, 15, 16.7 cpi
DP-9500A	9 x 9 impact	200	132/176	Y	N	N	1725	10, 12, 13.3 cpi
DP-9501A	11 x 9 impact	200	132/220	Y	N	N	1650	10, 12.5, 15, 16.7 cpi
DP-9620A	13 x 9 impact	200	132/220	Y	N	N	1845	10 cpi DP; 10, 12, 16.7 cpi NLQ
DP-9625A	18 x N impact	200	132/220	Y	N	Y	1945	10, 12, 16.7 cpi NLQ; 10 cpi DP
WP-6000	18 x N impact	330	132/220	Y	N	N	3250	10, 12 pitch Serifa, Helvetica, scientific
ANDERSON JACOBSON, INC.								
AJ 650	7 x 9 impact	180	80/132	N	N	Y	3400	ASCII, APL
AJ 862	5 x 9 impact	180	132/225	Y	N	Y	2995	ASCII, APL, graphics, international
APPLE COMPUTER								
Dot Matrix	7 x 9 impact	120		Y	N	Y	695	Pica 10, Elite 12, condensed, proportional
Silentype	5 x 7 thermal	40		Y	N	Y	350	Open Gothic
AXIOM CORP.								
EX401	5 x 8 electrosensitive	192	64	N	N	N	549-599	ASCII, graphics
EX420	11 x 20 electrosensitive	192	64/80	Y	N	N	849	ASCII, graphics
EX855	electrosensitive			Y	N	N	2995	
EX1601	5 x 8 electrosensitive	240	80	N	N	N	699	ASCII, graphics
EX1620	11 x 20 electrosensitive	960	80/160	Y	N	N	999	ASCII, graphics
EX1650	electrosensitive			Y	N	N	1595	
GP100	5 x 7 impact	30	80	Y	N	N	389	ASCII, international, graphics
IMP4	7 x 9 impact	100	80	Y	N	Y	749	14 x 18, ASCII, international, graphics
BURROUGHS CORP.							Did not respond; see directory for address	
C. ITOH ELECTRONICS, INC.								
1550	9 x 7 impact	120	80	Y	N	N	995	ASCII 96, JIS 160, CG graphics 64, others

Company Model	Printing method	Printing speed (cps)	Chars./ line	Graphics (Y/N)	Multi-color (Y/N)	Multi-pass (Y/N)	Unit price ($)	Specify fonts
8510A	9 x 9 impact	120	80	Y	N	N	795	ASCII, Swedish, UK, Japanese, graphics
8600	7 x 9 impact	180	80	Y	Y	N	1500	ASCII, Katakana, Greek, special, graphic
CANON USA						Did not respond; see directory for address		
CAPITOL CIRCUITS								
100	7 x 5 impact	65	27	N	Y	N	450	reverse normal, elongated
100T	7 x 5 impact	65	27	N	N	N	650	reverse normal, elongated
270	7 x 5 impact	65	27	N	N	N	650	reverse normal, elongated
S400		150	40	N	N	N	770	reverse normal, elongated
S400T		150	40	N	N	N	770	reverse normal, elongated
CENTRONICS DATA COMPUTER CORP.								
122	impact	120	132	Y	N	N	995	switch-selectable
150	9 x 7 impact	150	80	N	N	N		
152	9 x 7 impact	150	132	N	N	N		
159	9 x 7 impact	150	80	N	N	N		
351	7 x 9 impact	200	132	Y	N	Y	2195	96 ASCII, 7 international sets
352	7 x 8 impact	200	132	Y	N	N	1795	96 ASCII, 7 international sets
353	7 x 9 impact	200	132	Y	N	Y	2495	96 ASCII, 7 international sets
COMPRINT								
912S	9 x 12 electrosensitive	225	80	N	N	N	495	96 ASCII
912GP	9 x 12 electrosensitive	225	80	N	N	N	495	96 ASCII
912P	9 x 12 electrosensitive	225	80	N	N	N	495	96 ASCII
COMPUTER TRANSCEIVER SYSTEMS, INC.								
420 RO	7 x 5 impact	80	140	Y	N	N	795	14 print sizes
P200	7 x 5 thermal	120	136	Y	N	N		9 x 11 dot characters, custom fonts
DATA GENERAL CORP.								
4350 series	7 x 7 impact	340	132	N	N	N	6450	ASCII, international
4422	9 x 9 impact	150	136	N	N	N	2290	ASCII
6193	7 x 9 impact	180	132, 220	N	N	N	4050	ASCII, international
DATA IMPACT PRINTERS								
84G	7 x 7 impact	100	132	Y	N	Y	795	10, 12, 16.5, 5, 6, 8.25 cpi
DIP 81	7 x 7 impact	100		N	N	Y	449	10, 5 cpi
DIP 81A	7 x 7 impact	100		N	N	Y	499	10, 12, 16.5, 5, 6, 8.5 cpi
DIP 92	7 x 9 impact	100		Y	N	Y	695	10, 12, 16.5, 5, 6, 8.25 cpi
DATA MACHINES INTERNATIONAL								
DMI40	5 x 7 impact	80	40	Y	N	Y	250	
DATA TERMINALS & COMMUNICATIONS						Did not respond; see directory for address		
DATAPRODUCTS CORP.								
M-100	14 x 9 impact	140	132	Y	N	N	1925, Q100	user-programmable fonts, pitches
M-120	7 x 7 impact	180	132	N	N	N	1685, Q100	wide selection
M-200	7 x 7 impact	340	132	N	N	N	1925, Q100	wide selection
DATASOUTH COMPUTER CORP.								
DS180	9 x 7 impact	180	132	Y	N	N		USASCII, 7 foreign

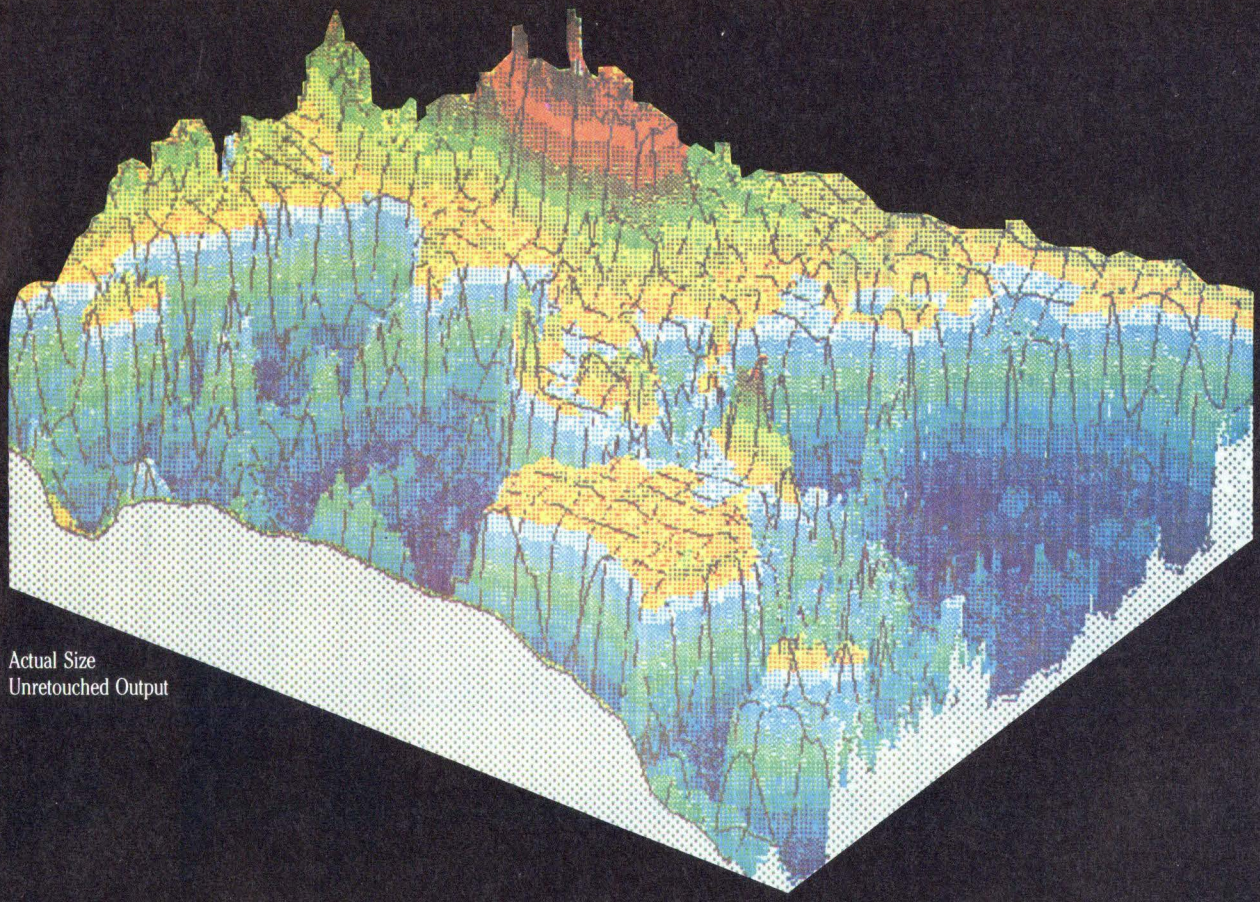
Company Model	Printing method	Printing speed (cps)	Chars./ line	Graphics (Y/N)	Multi-color (Y/N)	Multi-pass (Y/N)	Unit price ($)	Specify fonts
DATEL-INTERSIL								
APP-20A1	5 x 7 thermal	66	20	N	N	N	625	96 ASCII
APP-20A21	5 x 7 thermal	66	20	N	N	N	725	96 ASCII
APP-20A3	5 x 7 thermal	66	20	N	N	N	745	96 ASCII
APP-48A1	5 x 7 thermal	72	48	N	N	N	945	96 ASCII, others
APP-48A2	5 x 7 thermal	72	48	N	N	N	1040	96 ASCII, others
APP-48A3	5 x 7 thermal	72	48	N	N	N	985	96 ASCII, others
DPP-Q7	thermal	240	6	N	N	N	549	0-9 decimal, 0-F hexadecimal
DECISION DATA COMPUTER CORP.								
6541-02	7 x 5 impact	150	132	N	N	N	4195	96 characters standard, foreign optional
6541-05	9 x 5 impact	150	132	N	N	N	5314	96 characters standard, foreign optional
6541-07	9 x 5 impact	150	132	N	N	N	4463	96 characters standard, foreign optional
DI/AN CONTROLS, INC.						Did not respond; see directory for address		
DIGITAL EQUIPMENT CORP.								
LA12	9 x 9 impact	150	132	Y	N	N	1995	
LA120	7 x 7 impact	180	216	N	N	N	2750	
LA34/38	9 x 7 impact	30	216	Y	N	N	1270	
LA50	7 x 9 impact	100	132	Y	N	N	850	2 selectable
Letterprinter 100	9 x 9 impact	240	216	Y	N	Y	2860	Courier and Orator standard, foreign
EATON CORP.								
7000 +	impact	50	40	N	N	N	455	single-, double-width
ENVISION								
420	18 x 36 impact	300	258	Y	Y	Y	3950	italics, bold, Orator, foreign
EPSON AMERICA, INC.								
Custom Matrix Printer	9 x 9 impact	160	40/233	Y	N	Y		various
MX-100	9 x 9 impact	80	40/233	Y	N	Y		various
MX-80	9 x 9 impact	80	40/233	Y	N	Y		various
EXTEL CORP.								
AH-IIRV	5 x 7 impact	30	80	N	N	N	2080	64 Baudot, 64, 96, 128 ASCII
AL	5 x 7 impact	30	80	N	N	N	1310	64 Baudot, 64, 96, 128 ASCII
FACIT/DATAROYAL								
4510	9 x 15 impact	100	40/80	Y	N	N	695	multiple, 8 foreign
4542	9 x 9 impact	250	150	Y	Y	N	4125	proportional
4544	9 x 9 impact	250	150	Y	Y	N		
4570	9 x 9 impact	250			N	Y	3995	8 selectable
IPS 5000	9 x 9 impact	125	80/136	N	N	N	1110	96 ASCII
IPS 5000A	9 x 9 impact	150	80/136	N	N	N	1160	96 ASCII
IPS 5000C	9 x 9 impact	165	80/136	Y	N	N	1595	7 selectable
IPS 5000V	9 x 9 impact	165	80/136	Y	N	Y	2095	bar codes, selectable fonts
FLORIDA DATA CORP.								
OSP 120	16 x 36 impact	600	225	N	N	Y	3900	OCR-A, -B, 10, 12, 15, 17 pitch
OSP 130	24 x 36 impact	600	225	Y	N	Y	4100	OCR-A, -B, 10, 12, 15, 17 pitch, proportional
OSP 140	24 x 36 impact	600	225	Y	Y	Y	5100	OCR-A, -B, 10, 12, 15, 17 pitch, proportional

Company Model	Printing method	Printing speed (cps)	Chars./ line	Graphics (Y/N)	Multi-color (Y/N)	Multi-pass (Y/N)	Unit price ($)	Specify fonts
GENERAL ELECTRIC								
GE3181	9 x 9 impact	300	80	Y		N	1930	16 foreign, compressed, expanded, prog.
GE200 Document Handle	7 x 9 impact	200	105	N	N	N	5752	ASCII
GE200 Forms Access	7 x 9 impact	200	136	N	N	N	2705	ASCII, foreign
GE200 Line Printer	7 x 9 impact	200	136	N	N	N	2465	ASCII, foreign
GE200 Split Platen	7 x 9 impact	200	110	N	N	N	3895	ASCII, foreign
GE200KSR	7 x 9 impact	200	136	N	Y	N	2350	ASCII, foreign
GE200RO	7 x 9 impact	200	136	N	Y	N	2350	ASCII, foreign
GE2030KSR	9 x 7 impact	60	132	Y	N	N	1250	ASCII, foreign
GE2030RO	9 x 7 impact	60	132	Y	N	N	1175	ASCII, foreign
GE2120KSE	9 x 7 impact	150	132	Y	N	N	2195	ASCII, foreign
GE3180	9 x 9 impact	300	136	Y	N	N	1990	compressed, expanded, 16 foreign, prog.
GE3184	9 x 18 impact	300	136	Y		Y	2360	16 foreign, condensed, expanded, prog.
GE3185	9 x 18 impact	300	806	Y	N	Y	2300	16 foreign, expanded, compressed, prog.
GE3240	9 x 9 impact	400	136	Y		N	2340	16 foreign, compressed, expanded, prog.
GE3244	9 x 18 impact	400	136	Y		Y	2844	16 foreign, compressed, expanded, prog.
GE3400	9 x 9 impact	520	136	Y		N	2630	16 foreign, condensed, expanded, prog.
GE3404	9 x 18 impact	500	136	Y		Y	3085	16 foreign, expanded, condensed, prog.
GULTON INDUSTRIES, INC.								
GAP-132M	5 x 7 thermal	44	22	Y	N		345	6 x 8, 7 x 9
Microplot 44	thermal			Y	N		1090	ASCII
Microplot 80	thermal			Y	N		1945	ASCII
HARRIS CORP.								
4415	9 x 9 impact	165	132	N	N	N	3950	96 ASCII
HEATH CO.								
Z-25		150		Y	N	N	1595	
HEWLETT-PACKARD CO.								
HP2631B	7 x 9 impact	180	56-227	N	N	N	3900	128 ASCII, 8 ISO languages
HP2631G	7 x 9 impact	180	56-227	Y	N	N	4900	128 ASCII, 8 ISO languages, line drawing
HP2671A	9 x 15 impact	120	80/132	N	N	N	1195	
HP2671G	9 x 15 impact	120	80/132	Y	N	N	1495	
HP2673A	9 x 15 impact	120	40-132	Y	N	N	2195	
HI-G								
9/80 PS	9 x 9 impact	150	80	Y	N	N	995	ASCII
9/80 PSF	9 x 9 impact	75		Y	N	N	1295	ASCII
9/132 PS	9 x 9 impact	150	132	Y	N	N	1395	ASCII
HONEYWELL, INC.								
PRU1005	7 x 7 impact	120	132	N	N	N	3390	
PRU7060/7061	9 x 7 impact	100	80/132	N	N	N	1195	double-height, -width
PRU7065/7066	9 x 7 impact	100	80/132	N	N	N	1495	double-height, -width
PRU7070/7081	9 x 7 impact	100	80/132	Y	N	N	1195	double-height, -width
PRU7075/7076	9 x 9 impact	100	132	Y	N	N	1495	double-height, -width
IBM CORP.							Did not respond; see directory for address	

Company Model	Printing method	Printing speed (cps)	Chars./line	Graphics (Y/N)	Multi-color (Y/N)	Multi-pass (Y/N)	Unit price ($)	Specify fonts
INFOSCRIBE, INC.								
500	9 x 9 impact	150	136	N	N	Y	1530	ASCII, math, international
1000	7 x 9 impact	200	136	Y	N	Y	1895	ASCII, math, international
INTEGRAL DATA SYSTEMS								
Prism 80	18 x 9 impact	200	80	Y	Y	N	1299	international, 24 x 9
Prism 132	18 x 9 impact	200	132	Y	Y	N	1499	international, 24 x 9
Microprism 480	18 x 9 impact	110	80	Y	N	N	799	ASCII, 24 x 9
INTERNATIONAL MICROTRONICS CORP.							Did not respond; see directory for address	
IRWIN/OLIVETTI, INC.								
TH 240	7 x 5 impact	320	80	Y	N	N	440, Q500	multinational
LEAR SIEGLER, INC.								
310	9 x 7 impact	180	136/224	N	N	N	2045	6 resident selectable
Versaprint	9 x 12 impact	180	136/224	Y	Y	Y	1695	6 resident selectable
LEADING EDGE PRODUCTS								
1550	9 x 7 impact	120	132/231	Y	N	N	795	Pica, elite, proportional
8510A	9 x 7 impact		80/136	Y	N	N	995	Pica, elite, proportional
MALIBU ELECTRONICS CORP.							Did not respond; see directory for address	
MANNESMANN TALLY								
MT-160I	9 x 7 impact	160	80/160	Y	N	N	845	
MT-160L	9 x 7 impact	160	80/160	Y	N	Y	990	40 x 18 dot characters at 40cps
MT-180I	9 x 7 impact	160	132/264	Y	N	N	1095	
MT-180L	9 x 7 impact	160	132/264	Y	N	Y	1240	40 x 18 dot characters at 40cps
MT-1602/MT-1605	9 x 7 impact	200	132/218		N	N	1695	
MT-1802/MT-1805	9 x 7 impact	200	132/218		N	Y	1995	40 x 18 dot characters at 50cps
MDS TRIVEX								
8087	7 x 8 impact	180	132	N	N	N	4500	
MEMOREX COMMUNICATIONS GROUP								
1300	7 x 7 impact	100	80	N	N	N	950	
2087	7 x 9 impact	180	132	N	N	N	5995	
MICROTEK, INC.							Did not respond; see directory for address	
MINDWARE INC.								
MW-100	5 x 7 impact	16	16	Y	N	N	129	
MOTOROLA, INC.								
702	7 x 7 impact	120	10-132	N	N	Y	2500	64-character ASCII
703	7 x 7 impact	180	10-132	N	N	Y	3125	96-character ASCII
NCR CORP.								
2600	5 x 8 thermal	30	80	N	N	N		U/L case, ASCII with descenders
6410	7 x 7 impact	90	80	N	N	N		U/L case, ASCII
6425	5 x 7 impact	240	80	N	N	N		U/L case, ASCII
6441	7 x 7 impact	180	132	N	N	N		64-character ASCII
6455-2310	impact	33	132-198	Y	N	N	3075	selection of 50 print fonts
NOVELL DATA SYSTEMS, INC.								
I-800	9 x 9	150	80/224	N	N	Y	1295	96 USASCII, Korean

Company Model	Printing method	Printing speed (cps)	Chars./ line	Graphics (Y/N)	Multi-color (Y/N)	Multi-pass (Y/N)	Unit price ($)	Specify fonts
OKIDATA CORP.								
ML 80	7 x 9 impact	80	80	Y	N	N	449	USASCII
ML 82A	9 x 9 impact	120	80	Y	N	N	649	USASCII, foreign
ML 83A	9 x 9 impact	120	136	Y	N	N	995	USASCII, foreign
ML 84	9 x 9 impact	200	136	Y	N	Y	1395	USASCII, foreign
Pacemark 2350	9 x 9 impact	350	136	Y	Y	N	2550	USASCII
Pacemark 2410	9 x 9 impact	350	136	Y	Y	Y		USASCII
PANASONIC INDUSTRIAL CO.								
KX-P1090	many impact matrices	96	40/136	Y	N	N		
KX-P1160	many impact matrices	196	68/272	Y	N	N		
PRINTACOLOR CORP.								
PG-1000	14 x 9 inkjet	40		Y	Y	N	4995	user-definable
PRINTEK, INC.								
910	9 x 9 impact	200	227	Y	N	Y	1925	Courier-72, Elite-12, Pica-10, OCR-B
920	9 x 9 impact	340	227	Y	N	Y	2595	Courier-72, Elite-12, Pica-10, OCR-B
PRINTER SYSTEMS CORP.								
M100	9 x 14 impact	140		Y	N	N	2895	ASCII, international
M120	7 x 7 impact	180		N	N	N	2572	ASCII
M200	7 x 7 impact	340		N	N	N	2895	ASCII, international
P80/P132	24 x 18 impact	200/110		Y	Y	Y	1075	ASCII, international
T1600	7 x 9 impact	200		N	N	N	1695	ASCII, international
T1612	7 x 9 impact	200		N	Y	N	2295	ASCII, international
T1800	40 x 18 impact	50/200		N	N	Y	1995	ASCII, international, 18 x 9
PRINTER TERMINAL COMMUNICATIONS CORP.							Did not respond; see directory for address	
QUANTEX CORP.								
7020	many impact matrices	180	136/244	Y	N	Y	1625	APL, Trend, Courier
7030	many impact matrices	180	136/244	Y	N	Y	1995	APL, OCR-A, Script, others
QUME CORP.							Did not respond; see directory for address	
QWINT SYSTEMS, INC.								
RO 740	7 x 5 impact	65	137	Y	N	N	795	96 ASCII, Baudot, expanded, compressed
RACAL-MILGO								
4285	9 x 9 impact	120	80	Y	N	N	824	ASCII
RADIO SHACK								
DMP-100 (26-1253)	5 x 7 impact	50	80	Y	N	N	399	ASCII
DMP-200 (26-1254)	9 x 9 impact	120	80/132	Y	N	N	799	ASCII, 15 x 9, N x 23
DMP-400 (26-1251)	9 x 9 impact	140	132/220	Y	N	N	1195	ASCII
DMP-500 (26-1252)	9 x 9 impact	220	132/220	Y	N	N	1795	ASCII, graphics, 15 x 9, N x 23
DMP-2000 (26-1258)	9 x 7 impact	400	132/220	Y	N	Y	3795	ASCII, graphics, 18 x 40
RAMTEK CORP.								
4100 Colorgraphic	impact			Y	Y	N	9600	user-programmable
ROGERS PRODUCTS CO., INC.								
Typeprinter 221		30	198	N	N	N	2850	changeable daisywheels

Company Model	Printing method	Printing speed (cps)	Chars./ line	Graphics (Y/N)	Multi-color (Y/N)	Multi-pass (Y/N)	Unit price ($)	Specify fonts
SCI SYSTEMS, INC.								
1100	5 x 7 rotary	2200		Y	N	N	295, Q100	6 selectable
1110	5 x 7 rotary	2200	136	N	N	N	790, Q100	6 selectable
1180	5 x 7 rotary	1100	136	N	N	N	990, Q100	6 selectable
1800	7 x 9 rotary	6600	132	Y	N	N	1545, Q100	6 selectable
1870	7 x 9 rotary			Y	N	N	1580, Q100	6 selectable
SCM-KLEINSHMIDT							Did not respond; see directory for address	
SIEMENS CORP.								
2712-M201	12 x 14 inkjet	270	132/216	Y	N	N	3375	7 foreign, downloadable, multi-pitch
2712-M202	12 x 14 inkjet	270	80/132	Y	N	N	3225	7 foreign, downloadable, multi-pitch
2712-M203	12 x 14 inkjet	270	80/216	Y	N	N	3605	7 foreign, downloadable, multi-pitch
PT80-H	12 x 14 inkjet	90	80/132	Y	N	N		7 foreign, downloadable, multi-pitch
PT80-H16	12 x 14 inkjet	270	80/132	Y	N	N		7 foreign, downloadable, multi-pitch
STAR MICRONICS, INC.								
DP-8480	7 x 9 impact	80	80	Y	N	Y	399	international
Gemini-10	9 x 9 impact	100	80	Y	N	Y	499	many selectable
Gemini-15	9 x 9 impact	100	132	Y	N	Y	645	many selectable
TANDY/RADIO SHACK							Did not respond; see directory for address	
TEXAS INSTRUMENTS INC.								
743	5 x 7 thermal	30	80/136	N	N	N	995	
783	5 x 7 thermal	120	80	N	N	N	1595	
785	5 x 7 thermal	120	80	N	N	N	1995	
787	5 x 7 thermal	120	80	N	N	N	2395	
810	9 x 7 impact	150	132	N	N	N	1645	
820	9 x 7 impact	150	132	N	N	N	1995	
Enhanced 810	23 x 28 impact	225		Y	N	Y	2295	Courier, Helvetica or Elite, 10 or 12 pitch
TEXPRINT, INC.								
Texplot B	5 x 7 impact	30	136	Y	N	N	495	APL
Texplot C	5 x 7 impact	120	136	Y	N	N	475	ASCII, APL, foreign
TXP-136	5 x 7 impact	30	136	Y	N	N	375	ASCII, foreign
TRIFORMATION SYSTEMS, INC.							Did not respond; see directory for address	
VICTOR DATA PRODUCTS								
5080	7 x 5 impact	100	80	Y	N	N	995	
WANG LABORATORIES, INC.								
2233/5533	9 x 9 impact	120	158	N	N	N	2500	10, 12 pitch
2235/5535	9 x 9 impact	220	132	N	N	N	3500	10, 12 pitch
5577		192	198	Y	N	Y	5975	26 selectable draft and NLQ
WESTREX OEM PRODUCTS								
820 Series	5 x 7 impact	150	46	N	N	Y	220, Q100	
840	5 x 7 impact	150	40	N	N	Y	193, Q100	
8410/8400	5 x 7 impact	150	40	Y	N	Y	707, Q100	
851/852	5 x 7 impact	150	51	Y	N	Y	220, Q100	



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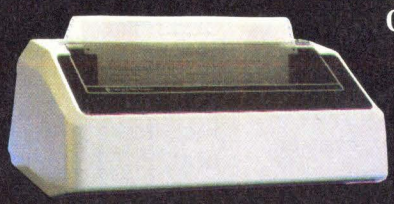

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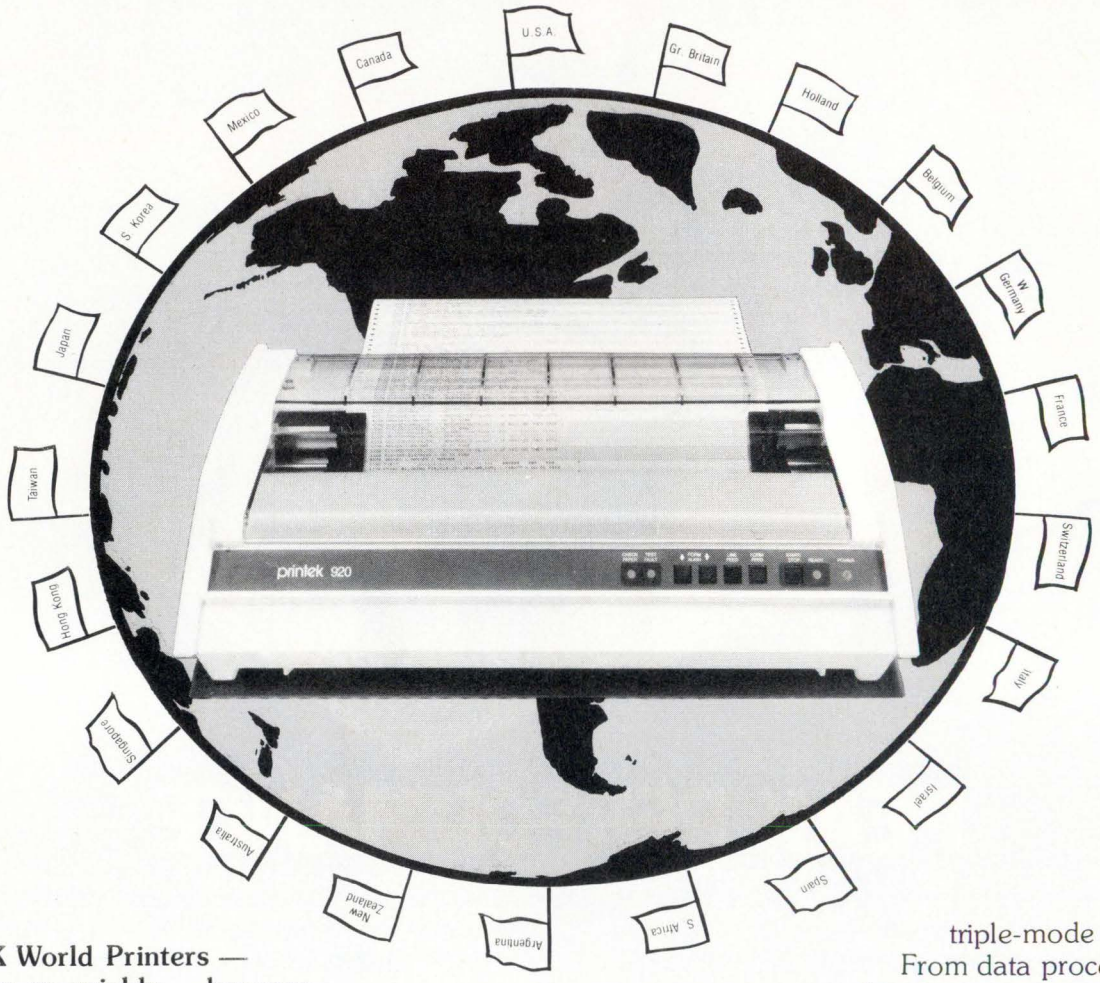

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PRINTEK 900 series printers had multi-national capabilities designed in from the beginning. No last-minute patch jobs, no evolving designs, but careful, thoughtful engineering at the outset to assure world-wide acceptance.

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CIRCLE NO. 143 ON INQUIRY CARD

PERIPHERALS DIGEST

Evaluating band printers

ROBERT ROSS, Digital Associates Corp.

OEMs should shop carefully for the right combination of reliability, convenience and performance

In the past, selecting a line printer was relatively simple. The selection was limited, and the machines were fairly simple to understand. Drum printers satisfied most hard-copy needs with sufficient speed and reliability.

But data-processing needs have changed, and printer technology has developed to meet those needs. After many years of faithful service, the dependable drum printer is being phased out of the data-processing scene, and soon, most models will be out of production. Although reliable, these printers lacked the versatility necessary in today's data-processing environment.

The most versatile fully formed character line printers available are band printers. To take advantage of this technology, OEMs should familiarize themselves with the basic components, features and service requirements of band printers.

Print mechanisms

All methods of solid-font impact line printing use the same type of mechanical action: an actuator, or solenoid-type device, contacts the rear of a hammer assembly whose hardened steel face strikes a print medium. The ribbon and paper are between the hammer face and the type character. In some cases, the actuator and print hammer are combined in one mechanism. There is usually one hammer and actuator for each column.

Drum printers use a cylindrical, steel drum embossed with print characters (Fig. 1). As the drum rotates at high speed, timing marks on its end allow the printer's logic to determine which character is in front of each hammer at any given time. When most characters are at the columns in which they are to be printed, those hammers fire. The printer's logic can scan hammer-to-character alignment many times before an entire line of information is printed and the paper is advanced to the next line.

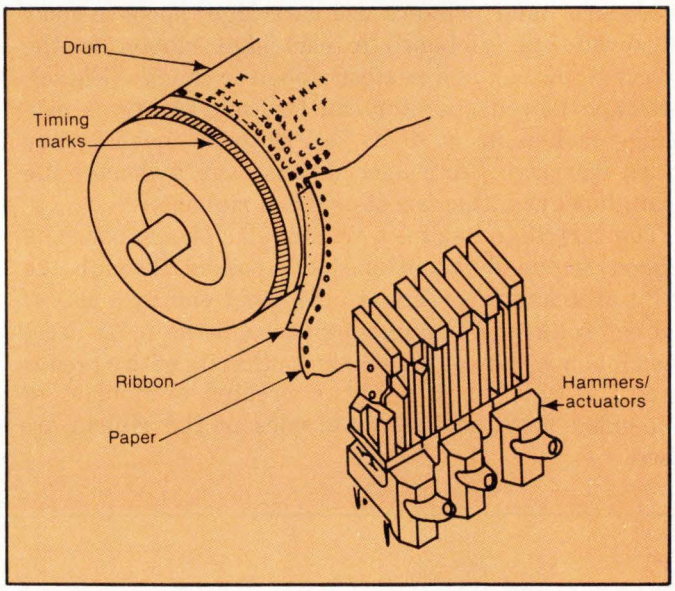


Fig. 1. A drum printer's embossed steel drum *rotates in front of print hammers, which strike the drum through ribbon and paper to form a printed character. Timing marks on the drum's edge enable the printer's logic to keep track of its position.*

Because these printers employ a vertically rotating font, drifting—the vertical misregistration of adjacent characters—is a common problem. Drifting can often be minimized or eliminated through flight-timing adjustments.

Chain and train printers use embossed slugs, each containing several character images (Fig. 2). These slugs are linked together or pressed into rubber belts and rotated horizontally between an idler and drive pulley. The print mechanism is similar to that of a drum printer, and each print position across the page has its own hammer and actuator assembly. Some manufacturers have successfully combined both chain and train

technologies, producing a printer with the qualities of both.

Chain/train-type printers are popular for their rugged construction and crisp print quality. They are expensive, however, and the chains are individually expensive and difficult to change.

Band printers use flexible, stainless-steel print bands photo-engraved with printable characters. The band is rotated horizontally, much like a chain, between an idler and drive pulley (Fig. 3). Band printers are relatively inexpensive, offer high-quality print and use easily changed print bands. If operated within the parameters for which they were designed, they are the best alternative to the outdated technology of a drum and the high-price and font-change difficulties of a chain/train printer.

Ribbon and paper drives

Modern band printers use cartridge, spool-to-spool or towel-type ribbons. A cartridge ribbon is the quickest, easiest and neatest ribbon to change (Fig. 4). An experienced operator can typically change a cartridge ribbon in 30 to 45 sec. without touching any inked material. Cartridge ribbons have a shorter life span, however, than spool or towel ribbons.

The cartridge itself is a rectangular plastic box. The ribbon is pulled out of one end, passed through the print area and force-fed into the other end by a pair of rubber rollers. While passing through the print area, the ribbon is skewed diagonally so that its entire area is used. A twist in the ribbon creates a Mobius, or one-sided loop, so that both sides of the ribbon are used.

When evaluating a printer that uses a cartridge ribbon, a user should investigate the printer's history of ribbon jamming. Some manufacturers have had problems with jamming around the rubber drive rollers. Most of these problems have been solved, however, by the use of positive-drive rollers driven by a cog-type belt rather than a V or O-ring type. In some instances, the rollers have been redesigned for better operation.

Spool ribbons in printers operate similarly to the spool-to-spool technology in older typewriters. Although they are more difficult and slightly more messy to change than cartridges, they provide longevity and trouble-free operation.

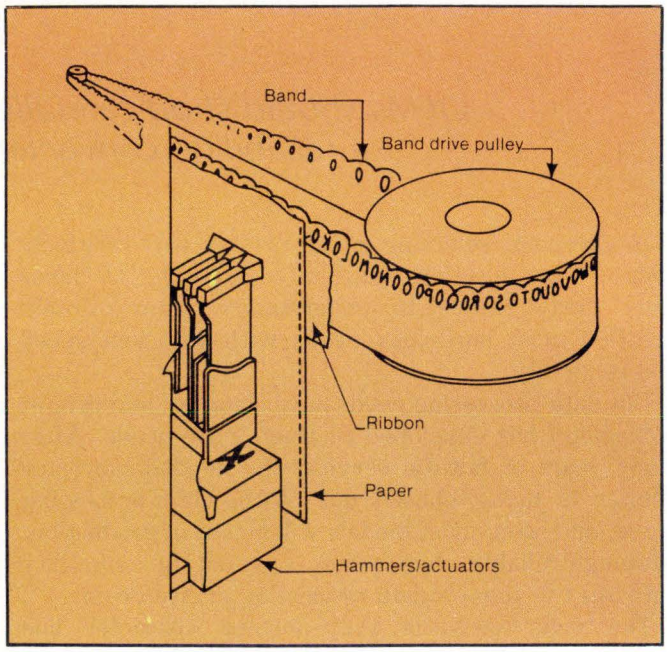


Fig. 3. A flexible-steel print band *rotates horizontally, but unlike chain or train slugs, the band can be changed in seconds.*

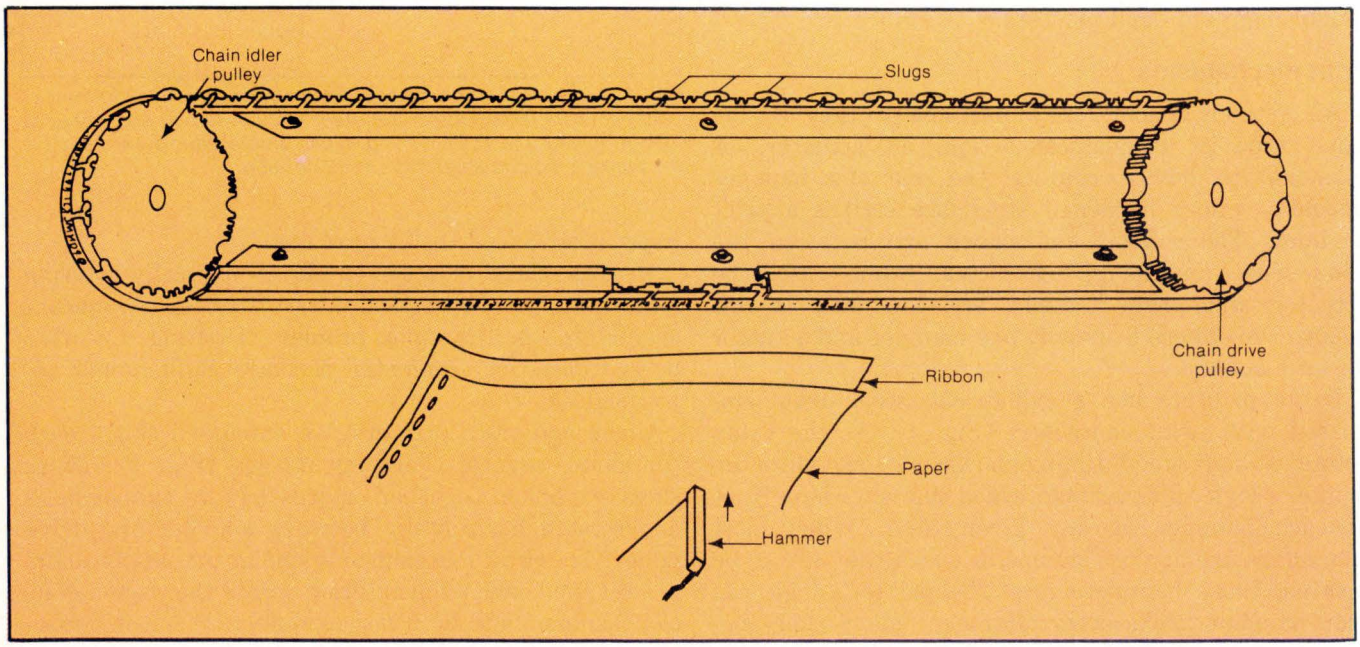


Fig. 2. A chain or train mechanism *uses embossed slugs that circulate horizontally between an idler and drive pulley.*

Much like a cartridge ribbon, a spool ribbon is skewed diagonally as it passes through the print area. It is somewhat wider than most cartridge ribbons (1 to 2 in.), and its increased area increases its life span.

Ribbon tracking, the accuracy of the ribbon winding onto its spool, is an important factor for spool ribbons. In some machines, ribbon-tracking adjustments are highly critical; a spool ribbon drive with poor tracking can cause the ribbon to fold and jam. One system used to monitor ribbon tracking employs sensors adjacent to each spool. These sensors detect ribbon centering problems while winding onto or exiting from the spool, and inhibit the machine's operation until the problem is corrected.

Sensors that act as switches perform ribbon reversal. These switches close when a conductive foil leader attached to each end of the ribbon passes through them.

Towel ribbons, named for their resemblance to rolls of paper towels, provide longevity and dependability. An inexperienced operator, however, may find them slightly difficult and messy to change (Fig. 5). A typical towel ribbon is approximately 14 in. wide and is recirculated between an upper and a lower spool, or mandrel. Ribbon reversal is accomplished, as it is in the spool ribbon, by sensing a foil leader at each end of the ribbon. Ribbon tracking is critical for towel ribbons, and a de-skew mechanism is needed. This mechanism compensates for the natural tendency of a ribbon to skew or wind onto the mandrel in a helical pattern.

Paper feeding is also crucial to reliable printer operation. The best paper-feed systems use reliable tractors that grip well and a direct paper path with few bends and turns (Fig. 6). Flat, rounded and pin-feed tractors have all proven dependable on popular band printers.

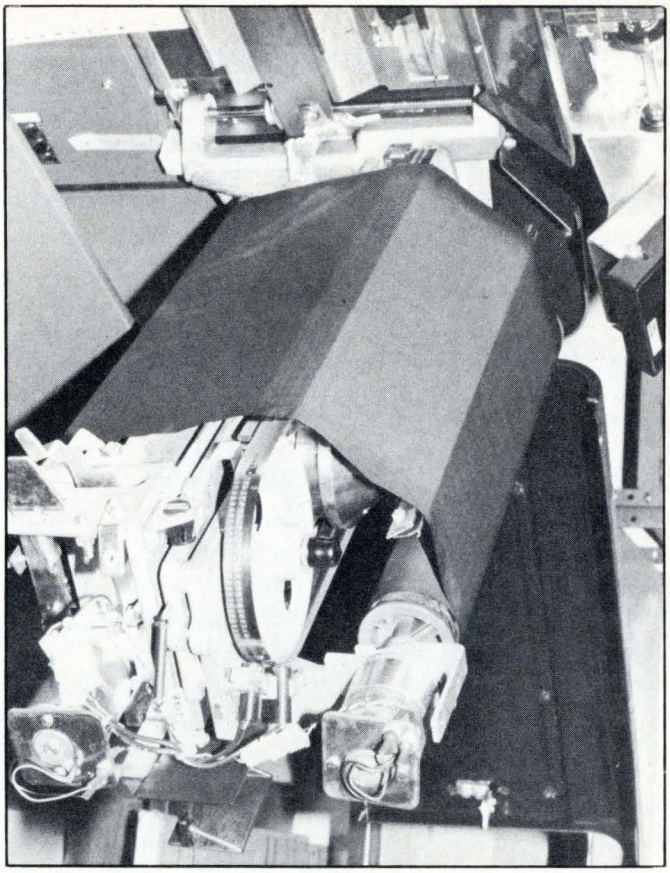


Fig. 5. A towel ribbon *has a long life, but can be inconvenient to change. Swing-open gate shown above makes access to ribbon easier.*

A poorly designed paper-feed system can tear through a form's sprocket drive holes when paper drag is slightly increased. Increased drag may be caused by the forms supply's being off center in the paper bay or

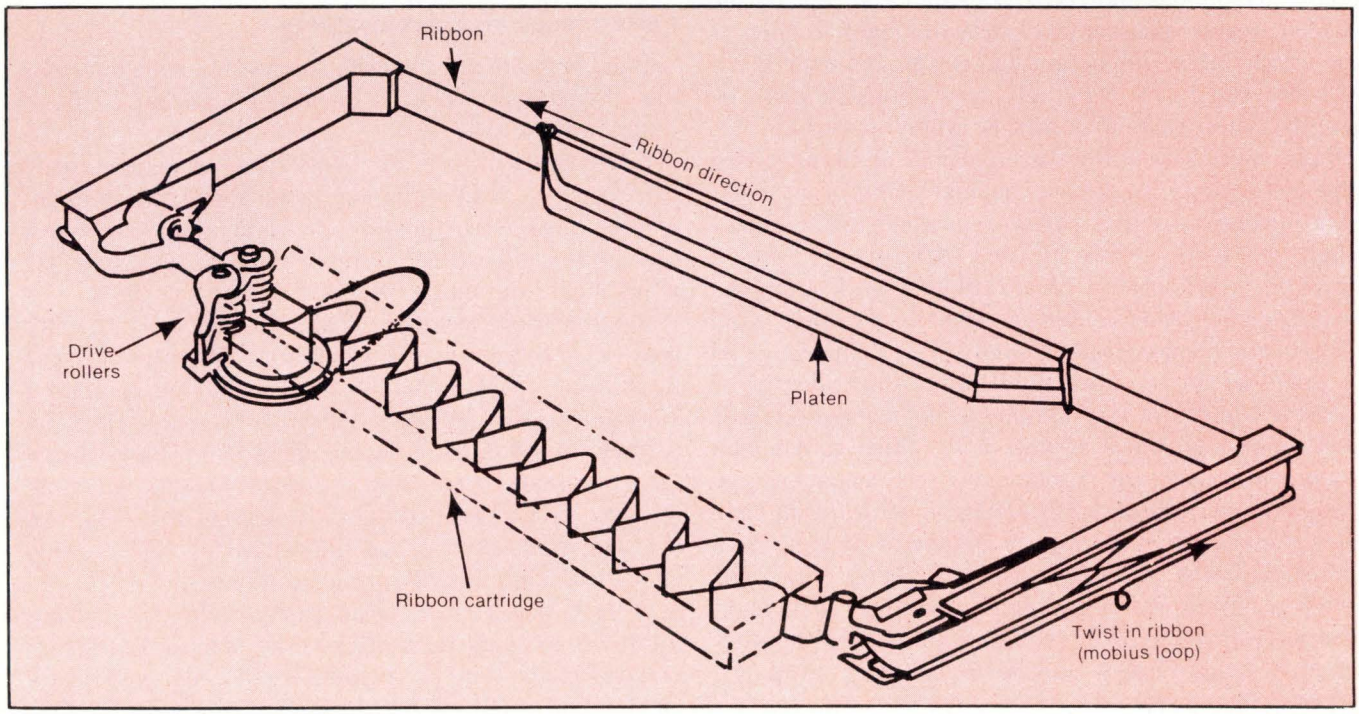


Fig. 4. A cartridge ribbon *for a band printer can be quickly and easily changed. The ribbon is drawn from one end, run through the print area and inserted into the cartridge's other end with a single set of drive rollers.*

by misadjusted spacing between tractors. A direct paper path reduces the chance of a paper jam; stiff or otherwise "difficult" forms may not travel smoothly through complicated wire-form guides. OEMs should request a demonstration showing how well a printer handles various forms.

Any operator can verify that ease of forms loading is important. Printers with a swing-open gate, a design borrowed from drum printers, load more easily than others.

Hammers, actuators and associated circuitry

Band printers typically use a separate hammer and actuator for each of 132 print positions. Most actuators use electromagnets, although those in the Dataproducts Corp. Mark Five band printer incorporate both electromagnets and permanent magnets.

Some printers use hammer banks that shuttle horizontally, with each hammer printing either two or four columns, depending upon a printer's speed. Because the print hammers are shared, fewer hammers, actuators and associated circuits are used. Because hammer driver circuits operate at high current, they are often less reliable than other components; reducing the number of circuits by shuttling hammers reduces down-time. Additional servo circuitry is necessary for horizontal movement of the hammer bank, but once adjusted, those circuits usually operate reliably.

An OEM should inspect a printer's hammer bank and actuators for ease of component replacement and cooling. Hammers and actuators should be replaceable without major disassembly. Actuator-bank cooling is one of the most important factors in determining a printer's reliability. The actuators should always be directly in the path of an airflow when operating.

Band printers employ various types of circuit-board interconnection. The most popular connection technique incorporates flat ribbon-type cables. The cables usually have connectors on each end that are labeled with their destination. Ribbon cabling can be cumbersome because many cables are used in a typical band printer, and can also become faulty after being removed a number of times, especially if removed carelessly.

A more dependable technique involves plugging all or most of a machine's circuit cards into a common receptacle board, or backplane. In backplane-type printers, each circuit card is slipped into a card cage along plastic tracks or rails. A connector on the card's rear edge mates with one on the backplane. All signals between circuit cards travel through the backplane, eliminating awkward ribbon cables. Backplane-equipped printers allow quicker circuit-card swap-out, and thus faster repairs.

Circuit cards used in band printers should be glass-epoxy or an equally durable material. Cards should not be excessively large and should be well-supported at all points. Because of a printer's high vibration while operating, large unsupported areas on PC cards can flex, causing hairline fractures that can create intermittently open circuits.

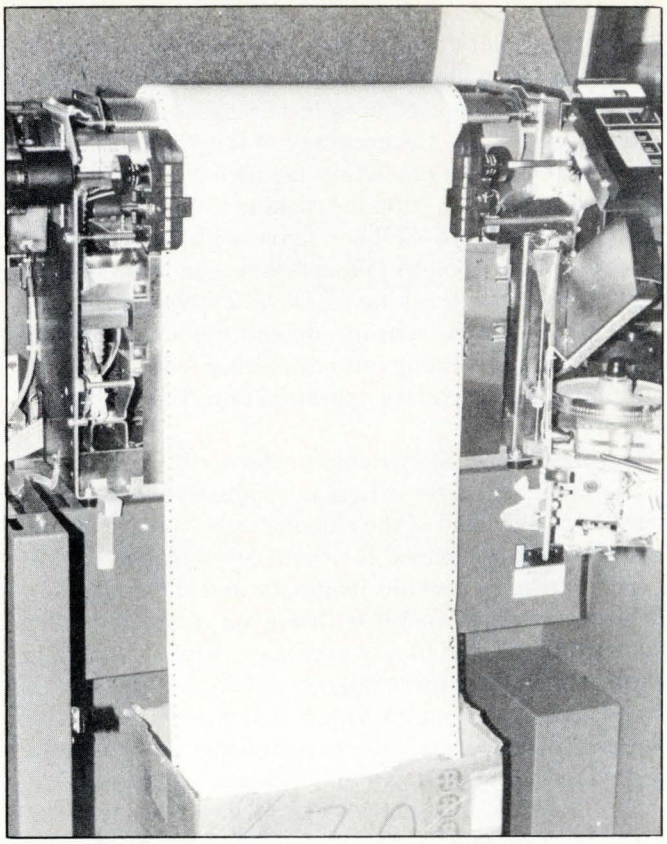


Fig. 6. Direct paper path *provides for fewer paper jams and more easily runs multi-part forms.*

Performance and serviceability

Band printers offer speeds from 300 to 3000 lines per min. Some units allow a service technician to field-upgrade their speed.

Print quality typically degrades as print speed increases. To achieve higher print speed, most band-printer designs require increased band speed, which can result in "ghosting," or blurred characters. Regular adjustments can minimize ghosting.

Band-printer technical manuals generally specify service schedules and reliability estimates. These figures are good indicators and should be compared among various models. The OEM should check a printer's mean time to repair and mean time between failure figures. The MTTR is the amount of time required for a trained service person to repair an average problem in a machine. MTBF is the average amount of hours between printer failures.

MTBF is based on a specific duty cycle—the recommended maximum ratio of time the printer is actually printing to the time the printer is powered on. Thus, a printer that is powered on for an entire 8-hour day but prints for a total of only 4 hours is operating at a

50-percent duty cycle. Judging a printer's durability on its duty-cycle or MTBF figure alone can be misleading. MTBF/duty-cycle figures should also reflect the number of lines printed per page and the column density of the printed pattern.

Despite the overall reliability of most band printers, a drum printer cannot be replaced by a band printer with equal reliability. If both a drum and band printer are operated at similar duty cycles, the band printer will probably require service more often than the drum. The severity of this shortcoming depends upon many variables, including which models are being compared.

The trend of the band-printer industry is toward modular components and fewer adjustments. Because of the increasing price of test equipment, many service companies do not have their technicians carry oscilloscopes, and few technicians can operate complicated diagnostic equipment. An OEM that has band printers using outdated electronics requiring oscilloscope adjustments may soon find itself at a disadvantage.

To minimize down-time and speed repairs, most or all of a line printer's mechanical adjustments should be factory pre-set. Adjustments should not require special tools, which are often not available even to service technicians. Each of the printer's functions can be controlled by a microprocessor, providing extensive diagnostic capabilities. Subroutines for initialization, paper motion and print cycles can now be implemented in PROMs, which can usually be changed in minutes to accommodate additional or deleted options, such as vertical format units or new character sets.

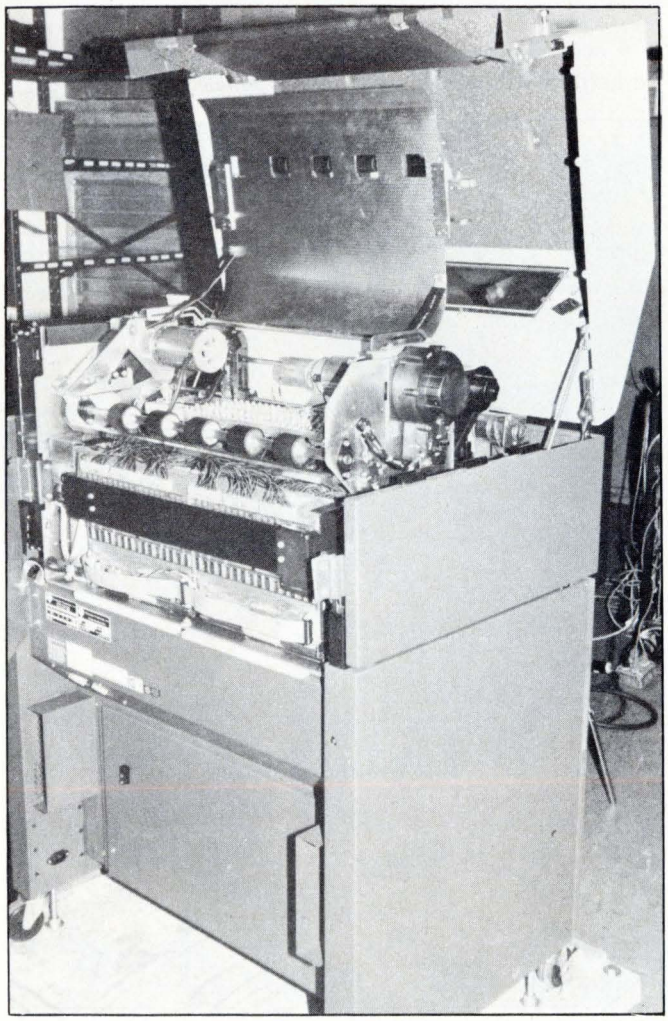


Fig. 7. Easy-access cabinets *incorporate canopies and panels that swing out of the way, exposing mechanical and electronic assemblies.*

Band printers should incorporate diagnostic displays. One or two seven-segment displays in Digital Associates Corp.'s printers inform an operator or service technician of as many as 60 diagnostic conditions, such as ribbon-motion fault, paper jam, paper out, band not seated properly and band-firmware-incompatibility error. Of these conditions, 20 to 25 are operator-correctable. The remaining diagnostics give a service technician an accurate account of the problem, often reducing troubleshooting time to a fraction of what it would otherwise be.

Well-written, unambiguous documentation is a must for a band printer's operator and service technician. Some manufacturers provide a theory of operation manual with flowcharts, and some of these include a section on troubleshooting.

Electronic logic diagrams should not use nonstandard logic symbols; such diagrams are useless to a service technician who lacks component-level knowledge of a machine. Diagrams, pictorials and schematics should be up-to-date and clearly drawn. A user should inspect all documentation before purchasing a printer because documentation often determines a machine's ease of repair.

Vertical forms control

Four methods of controlling paper motion in a band printer include: two- or 12-channel paper-tape vertical-format units, direct-access VFUs, forms-length selector switches and single-line feeds (no VFU control).

A 12-channel carriage tape is 1⅝ in. wide and as long as the form used in the printer. The tape's length is divided into segments, each representing a line of print on the form; an 11-in. tape is generally 66 lines long. The tape's width is divided into 12 segments, each representing a punch-hole-programmable channel.

The paper tape VFU allows the printer to "slew" forms—move them at high speed—until an optical reader recognizes a hole punched in a selected channel of the tape. When a hole is encountered in the tape, any information in the printer's line buffer is printed.

Industry standards dictate that channel 1 be used to represent top-of-form; thus, a channel 1 hole is usually punched at line 1. In most applications, channel 12 is reserved for bottom-of-form. This hole is generally punched at line 63, allowing three blank lines to avoid printing over the perforation line between forms. If a user chooses to print a one-line header at the top of each form, he would send one line of text to the printer followed by a "skip to channel 1," or "form-feed" command.

The remaining 10 channels can be punched to suit the user's needs. For example, channel 2 can be punched in every other line, and channel 3 can be punched in every third line. By terminating each line of data sent to the printer with a "skip to channel 2 or 3" command, the text would be printed every second or third line, respectively.

Two-channel VFUs operate similarly, but provide a user with the capability of punching only two channels of vertical-format information. This VFU is used for programming top-of-form and vertical tab only. Two-channel carriage tape is the same width as teletype punch tape. Unlike TTY tape, however, VFU carriage tape is opaque to infrared VFU sensors.

Most band printers load VFU tape information into a buffer on initialization, reading commands from the buffer instead of the tape itself. The VFU tape is no longer used after loading the buffer and can be removed from the printer.

VFU tapes are popular and versatile, but an operator must have a different tape for each form style used. A direct-access VFU provides the printer with the same capabilities as the 12-channel carriage-tape VFU without keeping an assortment of VFU tapes on hand.

A DAVFU-equipped printer is down-loaded from the system with all the information that would be found on a 12-channel carriage tape. The data are stored in the printer's DAVFU buffer. At the beginning of a DAVFU down-load, a start code is sent to the printer, signaling that what follows is DAVFU information. This information is loaded in a format similar to the layout of a 12-channel paper tape.

Two 8-bit bytes of DAVFU information are loaded for each line on the form being formatted. One line to 143 lines of information can be loaded. The 2 most significant bits are ignored in each byte, effectively leaving the VFU buffer loaded with one 12-bit word for each line. Each of these bits represents the status of a VFU channel for that line, bits 1 through 12 representing channels 1 through 12, respectively. A line of carriage-tape information is similar to a line of DAVFU information; a binary 1 in a DAVFU word is equivalent to a hole in a 12-channel carriage tape.

At the end of the DAVFU down-load, a DAVFU stop code is sent to the printer, signaling the end of DAVFU information. The DAVFU is accessed using the same codes as when accessing carriage-tape VFU.

A forms-length selector switch is a multiposition switch, with each position representing a form length. When a top-of-form or form-feed command is issued to the printer, it slews to the top of the form length selected. The forms-length selector switch is simple to use, but it provides a user only with variable top-of-form capability.

Using line feeds to move paper, with no VFU, is the simplest method, requiring no special hardware or tapes. It is, however, much slower than any of the other methods.

A band printer can be equipped with any combination of VFU types. If it has more than one type, the desired VFU can be selected by an operator with a switch on the control panel. In most cases, the printer will default to a VFU type upon initialization.

A 6- or 8-line-per-in. feature allows an operator to select the vertical spacing between consecutively printed lines. A printer operated at 8 lpi can print 88 lines on an 11-in. form.

Other features

Features vary among band printers, but some features have become particularly popular. Special access and control panels, quietizing, font-change and special I/O capabilities are among those OEMs should consider important.

An easy-access electronic bay allows quicker servicing. Swing-out card cages and canopies that open out of the way on a second set of hinges enable a service technician to swap out a defective card in minutes (Fig. 7). Earlier designs allowed access only after undoing several one-fourth-turn, or worse, full-threaded screws.

A second control panel in the rear of the printer can be helpful when adjusting forms stacking in the paper

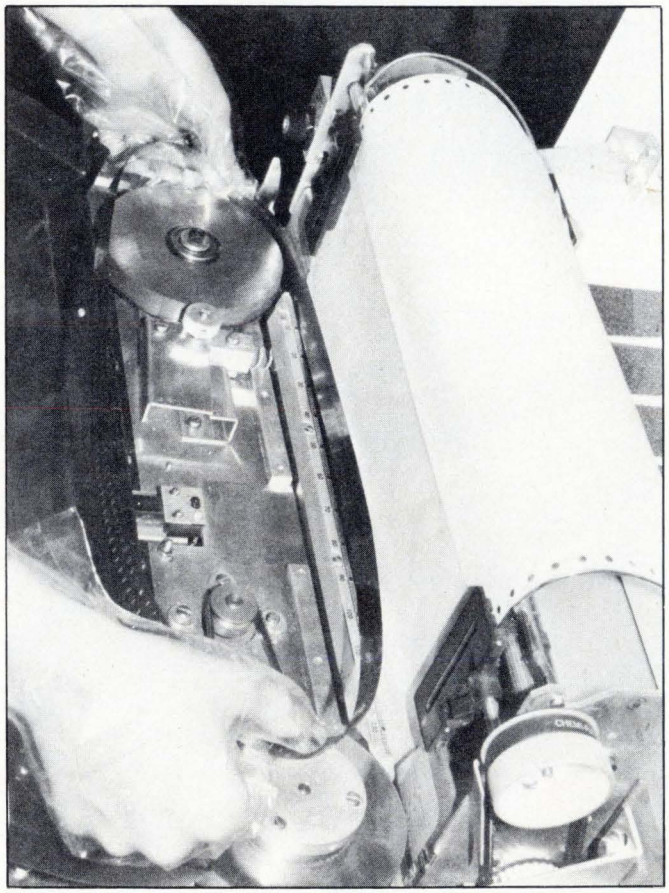
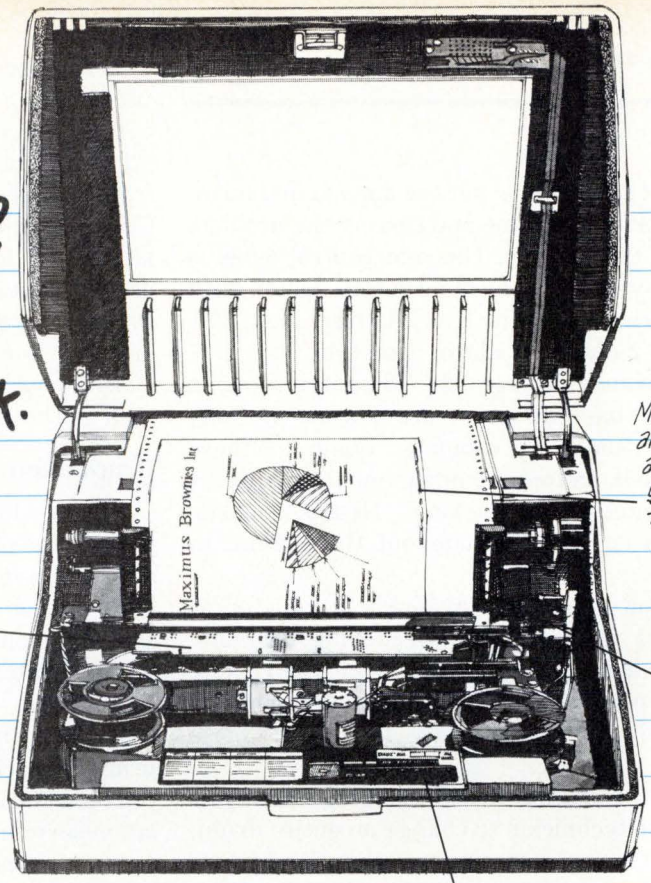


Fig. 8. Changing a print band *is a relatively simple operation. Bands are available for 48-, 64-, 96- and 128-character operation, as well as compressed print and a variety of font styles and languages.*

The Printronix MVP. The most printer reliability you can fit on a desk.



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tray or basket. If an operator notices a misfolded form, he can take the printer off-line and correct the problem from the rear of the printer. The rear control panel is usually a smaller version of the main control panel, with controls such as run, stop, line feed and form feed. The panel might also indicate an alarm condition.

To make the transition from the computer room to the office, many band printers are housed in fully enclosed, sound-deadening cabinets. Some of these cabinets have front and rear compartments for forms supply and printed-copy stacking. Heavy acoustic padding or foam is placed throughout the cabinet to reduce noise.

Many band printers are also available in tabletop or pedestal versions without sound-deadening cabinets. These printers are much noisier than their fully enclosed counterparts. The effectiveness of a printer's packaging largely determines its decibel or noise rating.

In the days of the drum printer, changing font styles required a service technician to change an entire drum, an expensive and time-consuming process. Band printers allow the operator to change font styles in seconds at a fraction of the price of changing drums (Fig. 8). Many English and foreign-character sets are available, and most manufacturers can also provide customized bands with font styles to fit specific needs. Multiple-band image PROMs plug into a printer's logic, allowing changing bands quickly without changing the related firmware each time. Character and index markings on the band enable the printer's logic to identify it after its first few rotations. After the band is identified, the printer's logic selects the appropriate PROM for that band. Today, as many as three band image PROMs can be installed at once.

Compressed-font bands print the ASCII 64-character set at 15 characters per in., rather than the standard 10 with high-quality print, allowing for considerable paper savings. A 132-character line at 15 cpi is the same length as an 80-character line at 10 cpi, and 198 characters can be printed across a standard 14⅞- × 11-in. form. The different horizontal spacing of the characters makes 15-cpi bands usable only on printers with "double-duty" hammers that cover two columns at once, such as those that shuttle their hammer banks.

Most band printers can generate a 132-column test pattern, consisting of a repetition of a single character or a sequence of every character on the band. An operator enables the self-test feature from a switch on the control panel. The self-test is an excellent diagnostic tool, exercising most of the machine's mechanics and electronics.

I/O versatility is another important feature of most band printers. Service engineers can change a band printer's I/O from one parallel configuration to another or to a serial configuration in 30 min. The Data-products-compatible parallel interface is the most popular I/O configuration today. Other popular parallel I/O configurations are those compatible with printers from Centronics Data Computer Corp., Control Data Corp., Hewlett-Packard Co. and Data Printer Corp. RS232C I/O for asynchronous data communications is usually installed on-board, or inside, the printer. Printer OEMs often provide outboard serial interfaces offering X-on/X-off or Ack/Nak protocols. Outboard synchronous serial interfaces handle popular protocols such as the IBM Corp. 2780 and 3780 protocols.

Distribution channels

Price/performance should be considered within the parameters of a printing application. For example, if an application requires a low-noise, medium-duty, 600-lpm band printer with a fully enclosed cabinet, a light-duty, pedestal-mounted, 300-lpm printer cannot be used. The wrong printer for a job is a constant source of irritation to its users.

There are many sources from which to purchase band printers, each with its own level of support. Support can be defined as technical/application expertise, installation/service capabilities and the availability of spare parts, ribbons and accessories.

CPU suppliers buy from line-printer manufacturers and resell in any quantity with small discounts for multiple purchases. Printer prices and the cost of support from this source are high, but support is generally good. CPU vendors often regard printer sales as a necessary evil in selling their processors, and none manufacture their own band printers.

Printer manufacturers typically sell only to customers that make a minimum commitment for 50 units annually. Technical support from the manufacturer is limited, and restricted to the warranty period on an as-available basis. Buying from the manufacturer is the least expensive alternative if support isn't required.

Distributors and brokers are frequently small operations that sell printers in small quantities at discount prices. The buyer is responsible for finding the appropriate controller/interface and arranging for installation/service. Support at this level is almost nonexistent.

Independent printer suppliers also buy from printer manufacturers and provide controller/interface packages comprising a plug-compatible subsystem. As printer specialists, these organizations often provide a greater choice of printer models than the CPU suppliers, as well as special-purpose products for individual applications. Prices are usually significantly lower than those of CPU suppliers. Further, delivery is quicker, and support is acceptable. □

Robert Ross is technical specialist at Digital Associates Corp., Stamford, Conn.

Nobody offers you a wider variety of computer printers and printer experience than Facit/Dataroyal ... all the way from low cost ($695 list) matrix printers, to sophisticated graphics and color matrix printers, to models that print variable size characters and bar codes, to "daisy wheels" and a multimode near-letter quality printer. Industry standard parallel and RS232C serial interfaces are available in all printers.

Our products are built to perform day after day in the most rugged environments. We achieve that kind of reliability by incorporating modern, trouble-free LSI circuitry, and fewer moving mechanical parts along with a high level of quality control.

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Printers, Printers and more Printers.

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BOOTH 5359

CIRCLE NO. 145 ON INQUIRY CARD

LINE PRINTERS

Company Model	Printer type	Speed (LPM)	Char line	No. of copies	Specify fonts	Price ($)	Special features
CENTRONICS DATA COMPUTER CORP.							
6080	band	600	132 136	6	IBM 1403, OCR-A, -B	8525	60 dba noise level, 12-channel VFU, self-test, paper sensor
6081	band	600	132 136	6		7120	12-channel VFU, self-test, paper sensor
9372-I	train	1200	132 136		ASCII, special fonts		acoustic cabinet, operator changeable type arrays
9372-II	train	1600	132 136		ASCII, special fonts		acoustic cabinet, operator changeable type arrays
9372-III	train	2000	132 136		ASCII, special fonts		acoustic cabinet, operator changeable type arrays
9373-III	train	2000	132 136		ASCII, special fonts		acoustic cabinet, operator changeable type arrays
9373-III	train	2000	132	6	ASCII	38160	12-channel VFU, towel ribbon, diagnostics
9380-12	band	1440	132	6	ASCII	13740	12-channel VFU, towel ribbon, diagnostics
9383E	band	360	132	6	ASCII, compressed	6875	12-channel DAVFU, towel ribbon, diagnostics
9386E	band	720	132	5	ASCII, compressed	7950	12-channel DAVFU, towel ribbon, diagnostics
9389	band	1130	132	5	ASCII	12550	12-channel DAVFU, towel ribbon, diagnostics
DATA GENERAL CORP.							
4327	band	300	132	6	USASCII	8900	
4364	band	600	132	6	USASCII	12900	
4373	band	1200	136	6	USASCII	28500	
DATA PRINTER CORP.							
1200	chain	1200	132	6	48, 64, 96 ASCII		
1210	chain	1000	132	6	48, 64, 96 ASCII		
1260	chain	600	132	6	48, 64, 96 ASCII		
3101	band	1000	132	6	48, 64, 96 ASCII		
3121	band	1200	132	6	48, 64, 96 ASCII		
3601	band	600	132	6	48, 64, 96 ASCII		
DATAPRODUCTS CORP.							
B-1000	band	1000	132	6	50 fonts, 250 + bands	7987, Q100	self-test, status display, parallel interface, line buffer
B-300	band	300	132	6	50 styles, 250 + bands	3823, Q100	self-test, status display, parallel interface, line buffer
B-600	band	600	132	6	50 font styles, 250 + bands	5122, Q100	self-test, status display, parallel interface, line buffer
BP-1500	band	1500	132	6	many	11300, Q50	self-test, status display, direct-access VFU, parallel I/F
BP-1800	band	1800	132	6	many	13800, Q50	self-test, status display, direct-access VFU, parallel I/F
DIGITAL ASSOCIATES CORP.							
T-200	impact matrix	200	132 224	6	64,96 ASCII		price varies with interface
1260	chaintrain	600	132 136	6	64, 96, 128 ASCII		price varies with interface
1210	chaintrain	1000	132 136	6	64, 96, 128 ASCII		price varies with interface
1200	chaintrain	1200	132 136	6	64, 96, 128 ASCII		price varies with interface
3601	band	600	132 136	6	48, 64, 96 ASCII		price varies with interface
3101	band	1000	132 136	6	48, 64, 96 ASCII		price varies with interface
3121	band	1200	132 136	6	48, 64, 96 ASCII		price varies with interface
B-300	band	300	132 136	6	48, 64, 96 ASCII		price varies with interface

LINE PRINTERS

Company Model	Printer type	Speed (LPM)	Char/ line	No. of copies	Specify fonts	Price ($)	Special features
B-600	band	600	132/136	6	48, 64, 96 ASCII		price varies with interface
B-1000	band	1000	132/136	6	48, 64, 96 ASCII		price varies with interface
9383E	band	300	132/136	6	48, 64, 96, 128 ASCII		price varies with interface
9386E	band	600	132/136	6	48, 64, 96, 128 ASCII		price varies with interface
9389E	band	900	132/136	6	48, 64, 96, 128 ASCII		price varies with interface
9380-12	band	1200	132/136	6	48, 64, 96, 128 ASCII		price varies with interface
2260	drum	600	136	6	48, 64, 96, 128 ASCII		price varies with interface
2290	drum	900	136	6	48, 64, 96 ASCII		price varies with interface
2470	drum	1250	132/136	6	48, 64, 96 ASCII		price varies with interface
2550	band	1200	132/136	6	48, 64, 96 ASCII		price varies with interface
T-510	belt	340	132	6	48, 64, 96 ASCII		price varies with interface
T-340	belt	340	132	6	48, 64, 96 ASCII		price varies with interface
FUJITSU AMERICA, INC.							
M3020	belt	370	132/136	6		3640, Q100	
M3021	belt	670	132/136	6		4920, Q100	
M3023	belt	1040	136	5		7200, Q100	
GENERAL ELECTRIC CO.							
GE510	belt	240	132	6	ASCII, international sets, letter Gothic	5795	tractors
GE310/340	belt	240	132	6	ASCII	4170	bottom, rear feed
HARRIS CORP.							
4330	band	600	132/136	6	64 ASCII	14950	acoustic cabinet, controller
4335	band	450	132/136	6	96 ASCII	14950	acoustic cabinet, controller
4270	chain	900	132/136	6	96 ASCII	40900	acoustic cabinet, controller
4320	band	300	132/136	6	64 ASCII	9500	pedestal, controller
4325	band	240	132/136	6	96 ASCII	9500	pedestal, controller
4240	chain	1000	132/136	6	64 ASCII	29900	parallel long line controller
4250	chain	730	132/136	6	96 ASCII	30900	parallel long line controller
4260	chain	1200	132/136	6	64 ASCII	39900	parallel long line controller
HEWLETT-PACKARD CO.							
HP2608A	impact matrix	400	132	6	16 resident		16 channel VFU, self test, cartridge ribbon
HP2611A	chain	600	132	6	64, 96 ASCII	18110	12 channel VFU, long line I/O
HP2617A	drum	600	136	6	64, 96 ASCII, custom		12 channel VFU, U L listed
HP2619A	chain	1000	132	6	64, 96 ASCII		12 channel VFU, long line I/O
HONEYWELL, INC.							
PRU9109/ 9609	drum	900	136	6	OCR-B	26500	print speeds rated at 64-character set
PRU9117/ 9617	belt	300	136	5	OCR-B	11500	print speeds rated at 64-character set
PRU9118/ 9617	belt	600	136	5	OCR-B	17500	print speeds rated at 64-character set

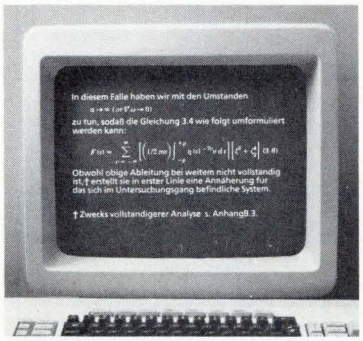
LINE PRINTERS

Company Model	Printer type	Speed (LPM)	Char/ line	No. of copies	Specify fonts	Price ($)	Special features
MANNESMANN TALLY							
T-3000 series	impact matrix	300	132	6	96USASCII		Quietized cabinet, self-test
NEC INFORMATION SYSTEMS, INC.							
L300	band	300	136	5	NEC Gothic, OCRB	5250	electronic VFU enhanced print, mode interfaces, Centronics
L600	band	600	136	5	NEC Gothic, OCRB	6920	electronic VFU enhanced print, mode interfaces, others
PRINTER SYSTEMS CORP.							
PSC-B1000	band	1000	132	6	standard ASCII, international character sets	11535	acoustic cabinet
PSC-B300	band	300	132	6	standard ASCII, national character sets	5588	
PSC-B600	band	600	132	6	standard ASCII, national character sets	7184	
PSC-BP1500	band	1200	132	6	standard ASCII, national character sets	19125	acoustic cabinet
PSC-T3000	impact matrix	300	132	6	standard ASCII, national character sets	5495	
PRINTRONIX, INC.							
MVP	impact matrix	200	132	6	multiple, programmable	3745	prints and plots at various resolutions
P150	impact matrix	150	132	6	multiple, programmable	5480	prints text and graphics
P300	impact matrix	300	132	6	multiple, programmable	6380	prints text and graphics
P600	impact matrix	600	132	6	multiple, programmable	8680	prints text and graphics
STC/DOCUMATION							
Impact 3000	band	1800	132/150	6	many		speeds to 3000 lpm, auto-stacker, VFU, direct-access VFU, counter
Univ. 1000	band	1000	132	6	many	14000, Q100	speeds to 1600 lpm, auto-stacker, VFU, direct-access VFU, counter
TELETYPE CORP.							
4CROP (asynch)	train	300	132	6	Murray, block, Prestige, Elite	7952	11C to 48CC bps, horizontal vertical tab, input buffer, others
4CROP (synch)	train	300	132	6	Murray, block, Prestige, Elite	7952	2400 to 7200 baud, RS232C, IBM 2770, 2780, 3770, others
TRILOG INC.							
C-100	impact matrix	250	220	6	ASCII	11500	compressed print, plotting, full color
C-144	impact matrix	190	132	6	ASCII	11500	compressed print, plotting, full color
T-100	impact matrix	250	132/220	6	ASCII, others upon request	8200	high-resolution plotting at 100x100 dpi
T-100A	impact matrix	250	132/220	6	ASCII, others upon request	9050	full Versatec 100 plotter, compatibility at 100x100 dpi
TIP 300	impact matrix	300	132/220	6	ASCII, Trilog letter quality	4900	compressed print, T.L.Q., nonstop printing, plotting
TIP150	impact matrix	150	132/220	6	ASCII, Trilog letter quality, others	3900	compressed print, T.L.Q., field upgradeable to 300 lpm, plotting
C-60	impact matrix	300	220	6	ASCII	11500	plotting full color

Diablo announces the first 400 character daisy wheel printer.

Because the world isn't as simple as ABC.

Until now, if a business needed a printer with a wide range of scientific or multilingual characters, the choices were severely limited. And so was the print quality. Not to mention that prices were high and reliability low.



But now Diablo introduces the 630 ECS* printer. The first 400 character daisy wheel printer in the world. For technical, legal, or multilingual business applications, no other printer comes close. It's the best alternative to twin daisy wheels and multi-pass matrix systems.

Only the Diablo 630 ECS gives you true extended character set applications on one print wheel. Printing at 33 cps average English text, the durable new print wheels developed by Diablo do more than just increase character count. They provide real compatibility between the system screen and the page.

What the host shows, Diablo prints. Without changing wheels. Even if it's $F(\tau) \approx \eta(\tau) \epsilon^{-2v} v\, d \rightarrow \infty$ ($or\ \nabla\omega \rightarrow 0$), for scientific applications. Or a combination 10 or 12 pitch or *italic type* for legal applications.

International business languages frequently call for hundreds of characters. Now, companies who use Teletex or any West European language can rely on a Diablo printer to do the work. And to do it without changing the print wheel.

The new 630 ECS printer is based upon the regular Diablo 630 which has an MTTR of less than 30 minutes and an MTBF of more than 4000 hours. And, except for the carriage, has common spares.

If you would like to know more about the Diablo 630 ECS, write to: Diablo Systems, P. O. Box 5003, Hayward, California 94545.

We believe it will shortly become the standard of the industry. It's as simple as that.

* Extended Character Set

Type shown not actual size.

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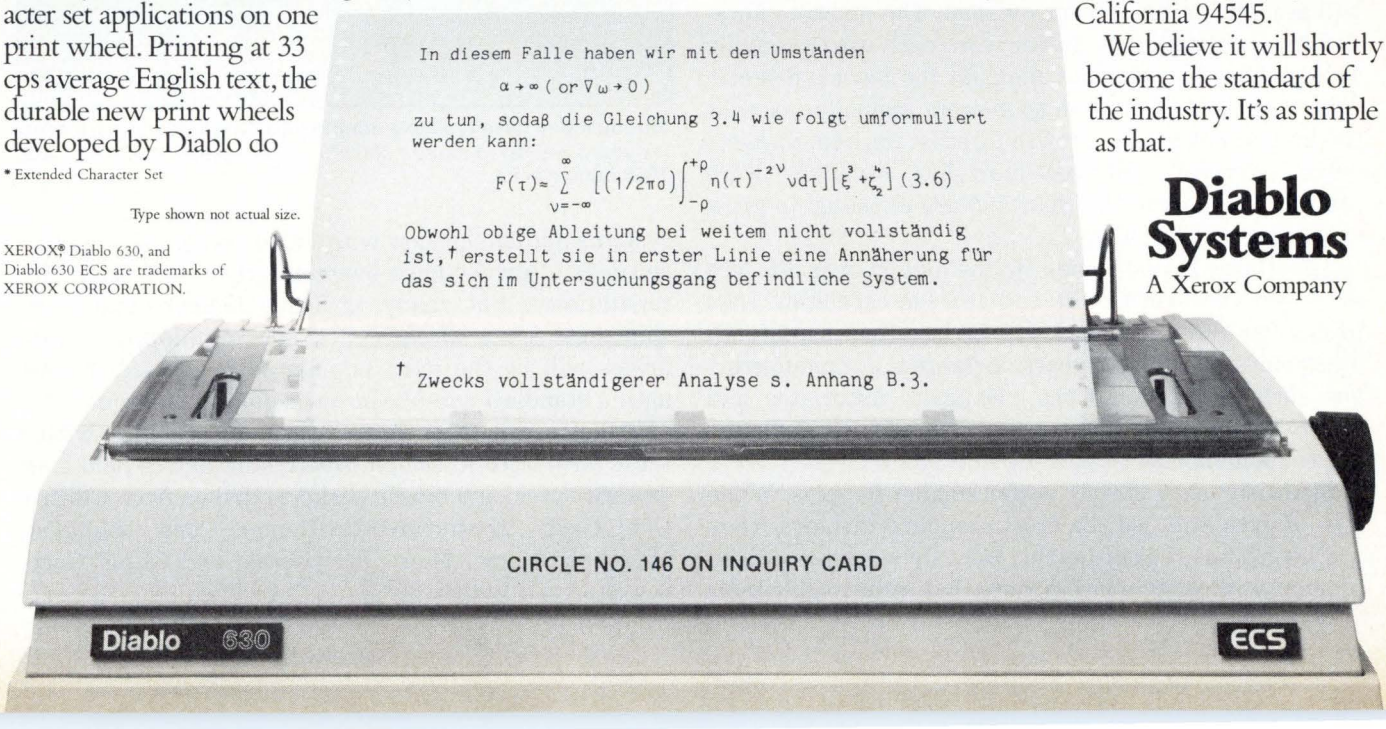
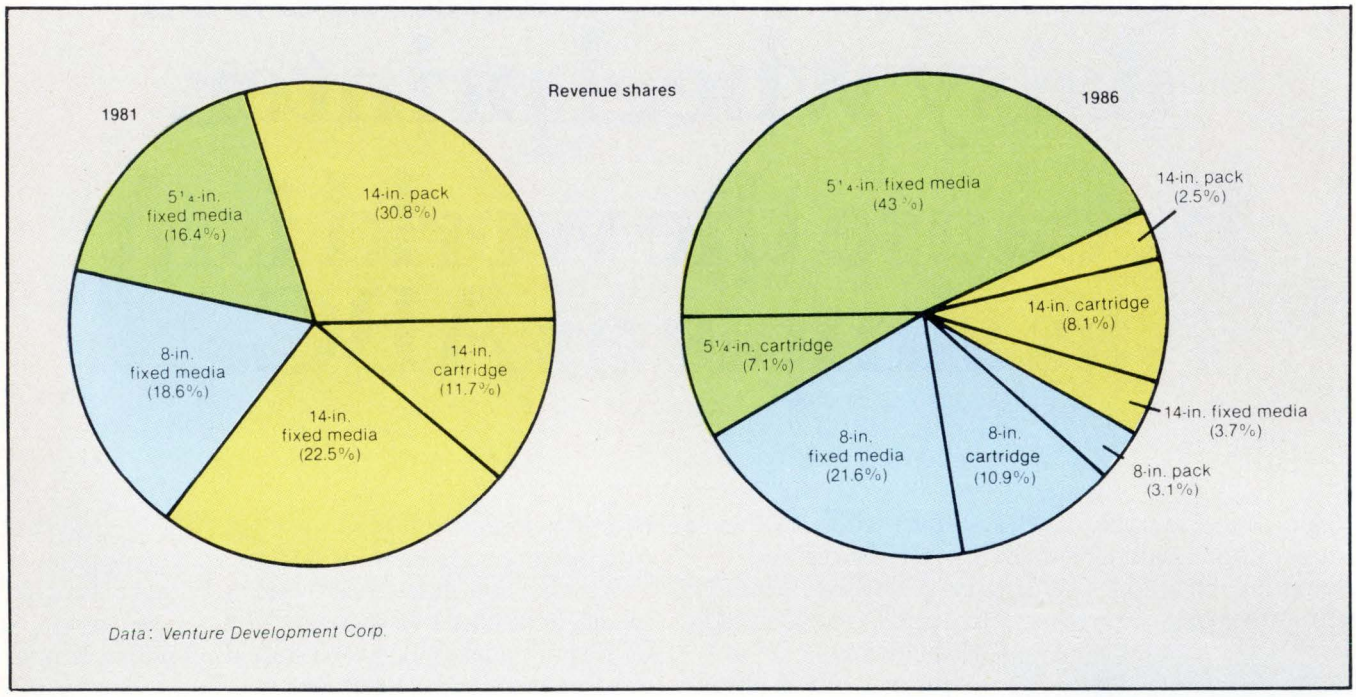


CIRCLE NO. 146 ON INQUIRY CARD

Disk market overview



End-user hard-disk revenues will grow *20.4 percent annually from $7 billion in 1981 to $17.8 billion in 1986, according to Venture Development Corp. Winchesters, which constituted 58.7 percent of rigid-disk dollars in 1981, will account for 82.8 percent of sales in 1986.*

The disk and diskette drive industries were more than prosperous in 1982. Unit prices kept falling, while performance, measured in storage capacity, access time, transfer rate and physical size kept improving. The most popular hard disks were 8-in. drives, followed by 14- and 5¼-in. sizes. Winchesters accounted for roughly 60 percent of end-user hard-disk revenues and will account for 82 percent by 1986. The markets for 8- and 5¼-in. floppy disk drives were each worth roughly $400 million in 1982, but demand for 5¼-in. diskette drives, estimated at 30 to 50 percent annually, exceeds the 20-percent annual growth forecast for 8-in. diskette drives. Overall end-user hard-disk revenues were roughly $8.4 billion this year and are expected to grow at 20 percent annually.

The three major issues in the floppy markets are drive prices, form factors and storage capacities. OEM prices for 5¼-in. floppies will be less than $200 (with electronics) within two years, as large U.S. manufacturers such as Tandon Corp., Shugart Associates and Micro Peripherals, Inc., exploit overseas manufacturing economies.

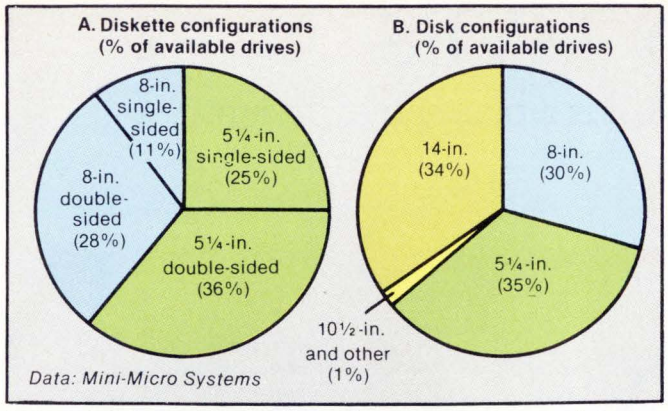
Sizewise, users clearly prefer smaller floppies. While 8-in. drives still use the most standard diskette, they are losing favor. Half-height, 8-in. drives have proved popular with system integrators that want to give their systems mid-life kickers without retooling, and double-sided, 8-in. drives have overcome their bad reliability reputations. But many analysts believe that 8-in. shipments have already peaked. Minifloppy 5¼-in. drives will be the most popular form factor, at least until a standard sub-5¼-in. microfloppy emerges.

Diskette capacities have begun to stabilize within these form factors. Double-sided, 8-in. drives hold 1.6M or 3.2M bytes, and 5¼-in. diskette drives from Control Data Corp., Irwin/Olivetti, Remex Corp., Shugart, Micropolis Corp., Micro Peripherals and Qume Corp. now store 1M byte.

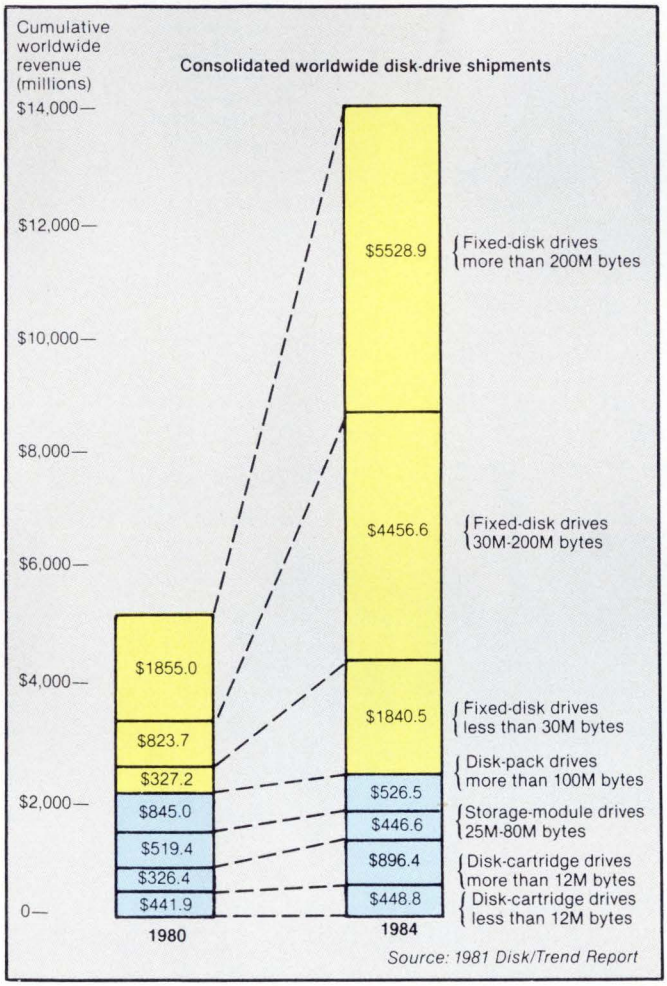
Disk-drive progress

IBM disk drive	First customer shipment	Recording density (bits per sq. in.)
350	1957	2.1×10^3
1311	1963	5.1×10^4
2311	1965	1.1×10^5
2314	1966	2.2×10^5
3330	1971	7.8×10^5
3340	1973	1.7×10^6
3350	1976	3.1×10^6
3370	1979	7.7×10^6
3380	(1981)	1.2×10^7

Introductions have typically doubled disk-storage *densities every 2½ years, leading to today's 5000-fold improvement compared with 1956 performance.*

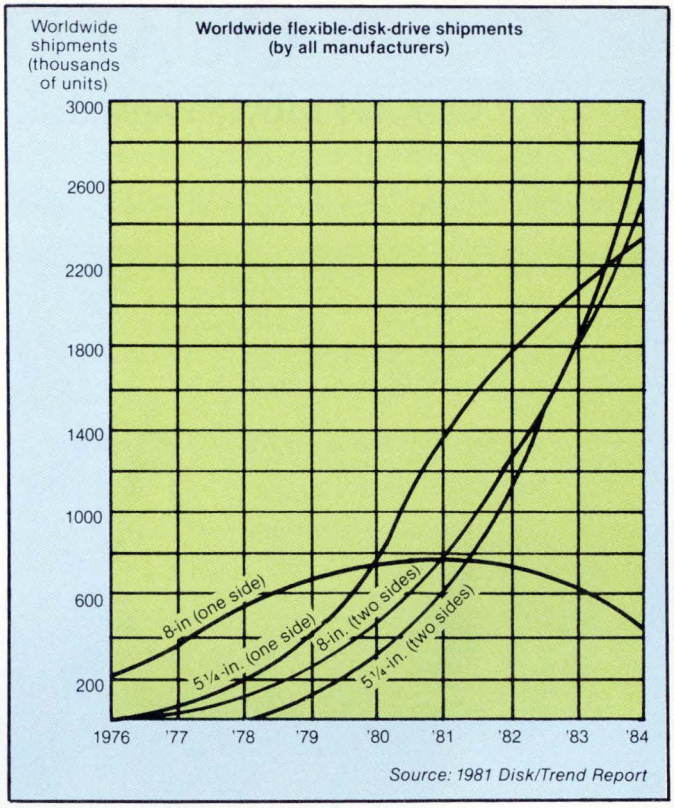


Disk and diskette drive configurations are numerous and change slowly *over time. The 5¼-in. disk drives are outselling all other rigid-disk-drive sizes, and 5¼-in. diskette drives are doing as well in their markets. The 10½-in. rigid disk drives have all but disappeared, and single-sided diskette drives of all sizes are losing market share. Makers of 3½- and 3¼-in. diskette drives are still competing to establish a standard size for sub-5¼-in. diskette drives.*



Disk-drive revenues will grow at least 29 percent annually through 1984. *Strongest growth will occur in the fixed-disk markets, with lower capacity Winchester drives leading the way.*

On the hard-disk side, recent developments center on increasing capacities and media removability. The 5M-byte, first-generation, 5¼-in. Winchesters of 1980 gave way to 2M- to 40M-byte, 5¼-in. Winchesters in 1981 and 1982, and prototypes for 60M- to 180M-byte, 5¼-in. devices should appear by year-end. This year,



Floppy-disk shipments reflect the trend toward greater floppy-disk capacity. *Shipments of single-sided, 8-in. drives have already peaked. Worldwide shipments of all types of floppy drives during 1980 totaled 2019 units and should be 8259 in 1984, a compound annual growth rate of 42 percent.*

Optical versus magnetic media (percentage by shipment value)

	1982	1985	1990
Floppy	51.3	52.8	46.9
Winchester	8.4	16.7	28.7
Hard pack	40.3	27.3	14.9
Optical	—	3.3	9.4
Total	100.0	100.0	100.0

Data: International Resource Development, Inc.

Storage-media growth will be paced by Winchesters and optical technologies *for the remainder of the decade. Winchesters will more than triple their current penetration by 1990. Optical devices, rare today, will grow 23 percent annually beginning in 1985.*

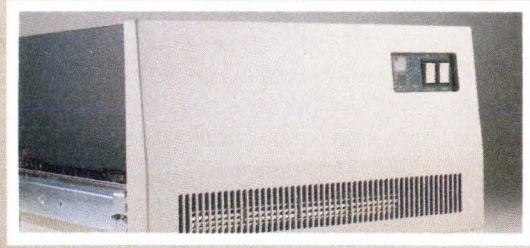
CDC, DMA Systems, Inc., and others announced new removable-disk units to cater to the backup needs of small system users. Optical disks could revolutionize first high- then low-end drive markets, but production optical disks are unlikely before 1984.

The mature high-end disk market should remain healthy as usual. The 8-in. disk market should prosper for a few more years, but is on the wane. The mini-Winchester and minidiskette markets are like the CRT market of the late 1970s. Dozens of new entrants are cropping up, and everyone knows a shakeout will come, but demand seems inexhaustible, the stakes are immense, and there's room for more than a handful of survivors. □

QUALITY LIVES

Our 474 Mbyte Eagle disk drive is a triumph of design.

This "skeleton" clock, hand-made from brass in England around 1860, still keeps nearly perfect time: contemporary spring-wound clocks have only one-tenth the accuracy of the older clock's single-train fusee movement. Its spring maintains constant tension by unwinding a chain off the increasing diameters of a conical barrel.



Like this nineteenth-century "skeleton" clock, our 474 Mbyte, 10.5-inch Eagle disk drive is a testament to human ingenuity. The Eagle has one of the highest capacities of any Winchester disk drive, yet fits in a standard 19-inch rack. Its quiet operation and low power consumption are in keeping with its small size. At Fujitsu America, we still seek the triumph of quality.

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FUJITSU

CIRCLE NO. 147 ON INQUIRY CARD

Mixing disk drive ingredients for your applications

GROVER MULLIN, Control Data Corp.

Choosing a hard disk drive involves finding a suitable price/performance combination

Hard or rigid disk drives lead all other storage technology media in capacity, access speed and price. However, the cost of disk drives is declining, and the selection is broad: disk drives are available in several disk diameters, technology levels, product configurations and capacities. Price/performance and packaging flexibility can result from these options, but choosing the right configuration can be complex. A disk buyer can quickly limit the likely candidates, however, by understanding the intended application, forecasting growth needs and applying the analysis. The "cookbook" approach to selecting the right drive for an application examines capacity, removability, performance, size, price and interface.

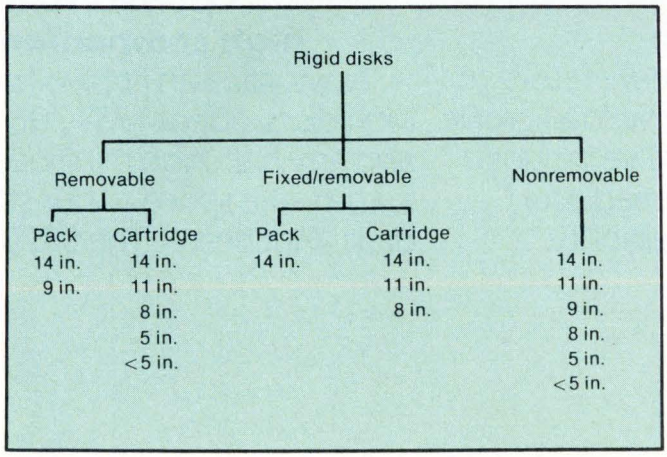
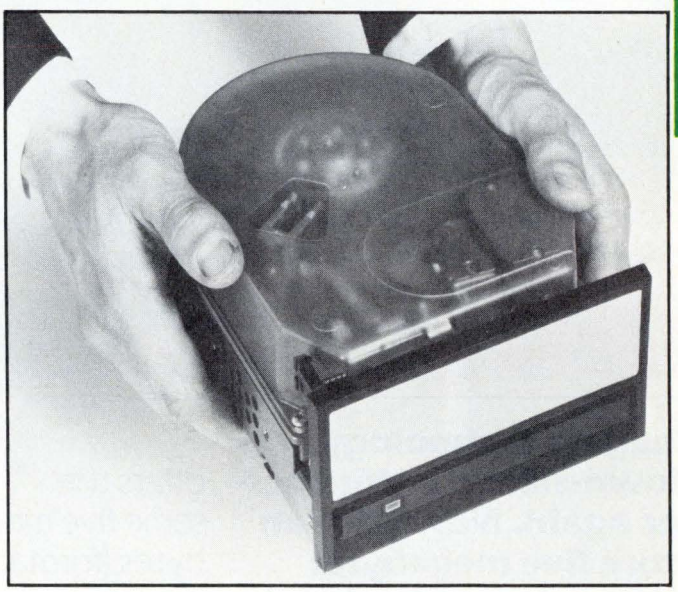


Fig. 1. Rigid disk drives allow many configuration options. *Fixed disk drives are best when overall capacity, cost or cost per megabyte are important, but for applications requiring data protection and physical data security, removable or fixed-removable drives may be more suitable.*



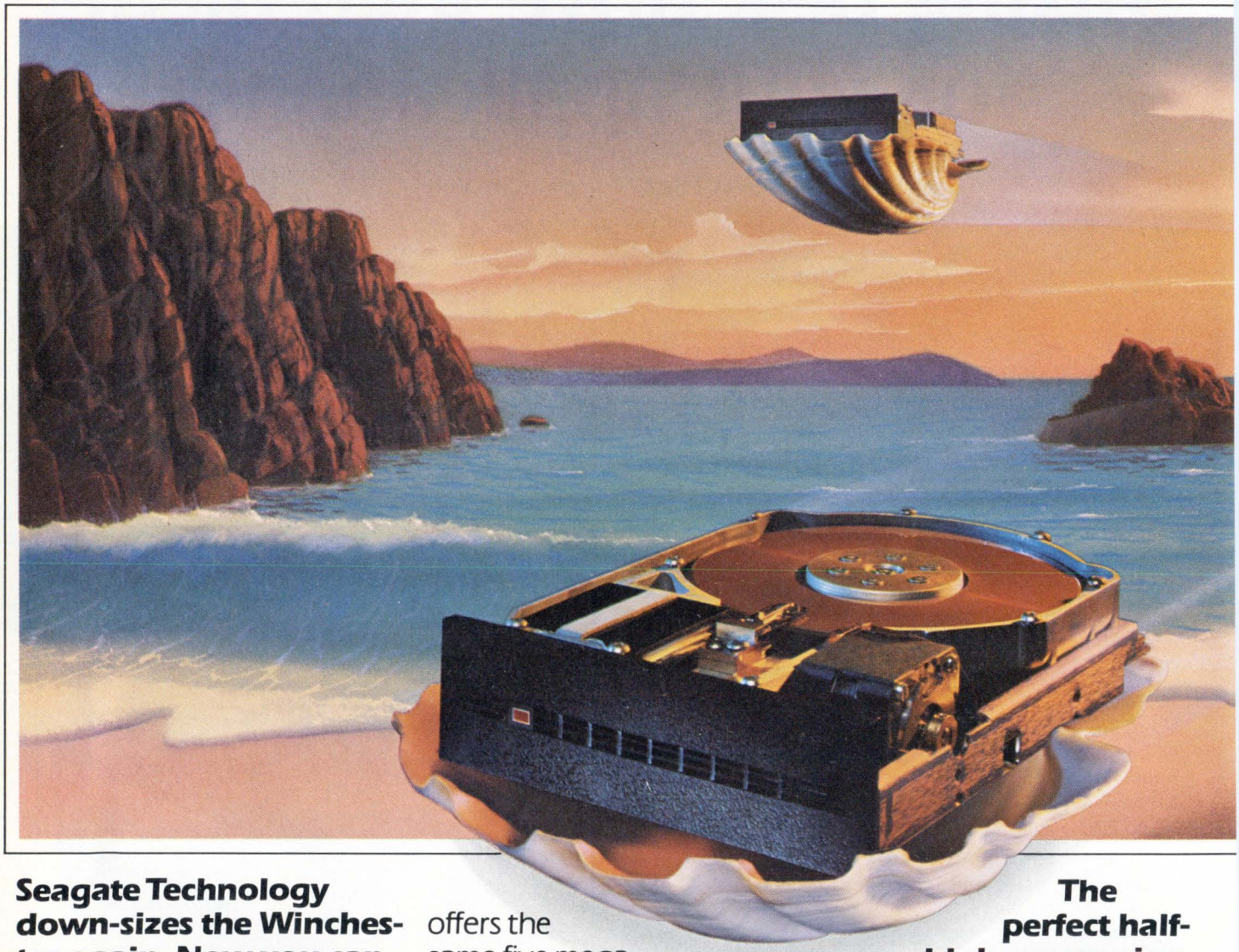
The 5 ¼-in. CDC 9415 Wren Winchester disk drive *stores 19M bytes of data in fixed, sealed data modules at densities of 8,730 or 9,000 bits per in.*

Look for large capacity

Capacities of today's rigid disk drives vary greatly (see table). Before evaluating drives, a disk buyer should determine the intended file size for his applications and multiply this size by the number of files to be stored.

Rigid disk products are available in diameters ranging from less than 5 in. to 14 in. for fixed *or* removable disk drives and 8, 11 and 14 in. for fixed *and* removable devices (Fig. 1). By 1987, the sub-5-in. disk

5Mb on the half-



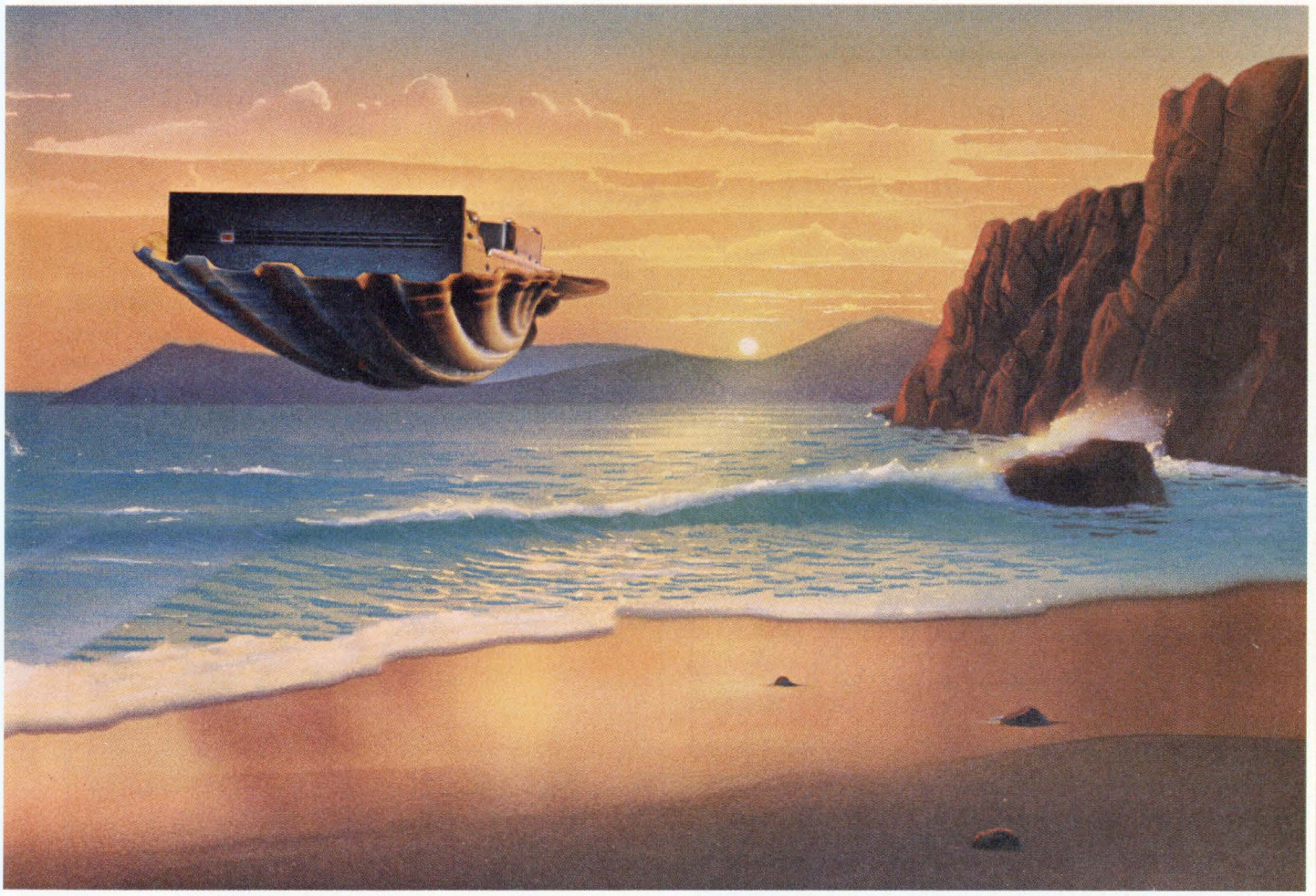
Seagate Technology down-sizes the Winchester again. Now you can store five megabytes on-line in half the height of our standard 5¼" Winchesters.

Our new half-high ST206 offers the same five megabytes (formatted) of storage capacity in a new, low-profile design. And we've included rugged plated media for even greater reliability.

The perfect half-high companion.

Now you can fit two half-high discs, our new ST206 and any half-high minifloppy, in the same space as our standard Winchester. The ST206 is

shell, from Seagate.



the perfect size for your new, low-profile system designs. It's also rugged enough for portable applications.

Nothing has changed but the size.

The half-high ST206 has the very same capacity and interface as the OEM's favorite Winchesters–the Seagate ST406 and our ST706 removable cartridge Winchester. It's just smaller.

Shrinking the cost of Winchester.

We've reduced more than size. The ST206 is an excellent value. Especially in volume.

Get small now.

Evaluation units are available now. So don't wait for promises. Call Seagate today and get five megabytes on the half shell.

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CIRCLE NO. 148 ON INQUIRY CARD

drive will effectively handle as much as 20M bytes; the 5-in. disk, 20M to 150M bytes; and the 8-in. disk, 150M to 450M bytes. Anything higher than 450M bytes will be handled on a 14-in. drive.

The limiting performance factor in real-time systems is disk access time, which depends on both system performance and disk drive technology.

Regardless of capacity, the total storage is generally divided into working, or scratchpad, storage, which consumes about 55 percent; permanent files, about 20 percent; and the operating system, about 15 percent.

Characteristics of medium	Magnetic tape	Cassette cartridge	Flexible disk	Removable disk	Optical	FDD magazine	Redundant disk	Communication system
Physical size	–	+	+	+	–	–	–	–
Access to data	–	–	•	+	+	–	+	–
Box cost	–	+	+	+	–	–	–	–
Storage cost	+	•	•	–	+	•	–	–
Integration	+	–	+	+	–	+	+	+
Ease of use	•	+	+	+	+	+	+	+
Transfer rate	•	–	–	+	+	–	+	–
Store capacity	+	–	–	+	+	+	+	+
Standardization	+	–	+	+	–	+	+	+
Maturity	+	•	+	+	–	–	+	+
Data integrity	•	–	–	+	+	–	+	+

+ = Advantageous • = Neutral – = Disadvantageous

Fig. 2. Rigid disks compare favorably in price/performance to other removable media. *In the three most significant categories—data access, transfer rate and storage capacity—they beat all contenders except optical storage and redundant disks. But optical disks are not reusable and are difficult to integrate with conventional technologies, and redundant disk storage is expensive and space consuming.*

This leaves about 10 percent of the total file space for future expansion. But the disk buyer should be cautious: "Disk space is like closet space; you never have enough," says one system designer.

Media removability increases security

The removable-media concept was inspired by economics because drives were very expensive compared to media. Today, removability provides backup for data in case a drive fails. A user then can move a pack or cartridge to another drive. The removability increases security as well because data can be moved to a protective site. Removable or fixed/removable drives are often appropriate in "creative" environments, such as programming-development and word-processing facilities.

Fixed media require a system designer to consider methods of removing critical data from the sealed media to prevent a disk failure or catastrophe from destroying his database. Fig. 2 is a subjective "plus, minus and neutral" evaluation of possible data-removal options. Communicating data to a remote disk is becoming a more common backup method.

Measuring performance

The limiting performance factor in real-time systems is disk access time, which depends on both system performance and disk drive technology. For example, mainframes require a 10- to 35-msec. access time; minicomputers, 25 to 55 msec.; and microcomputers, 50 to 200 msec. This data transfer rate can be optimized or degraded depending on the disk drive used.

The servo technologies of disk drives provide a wide

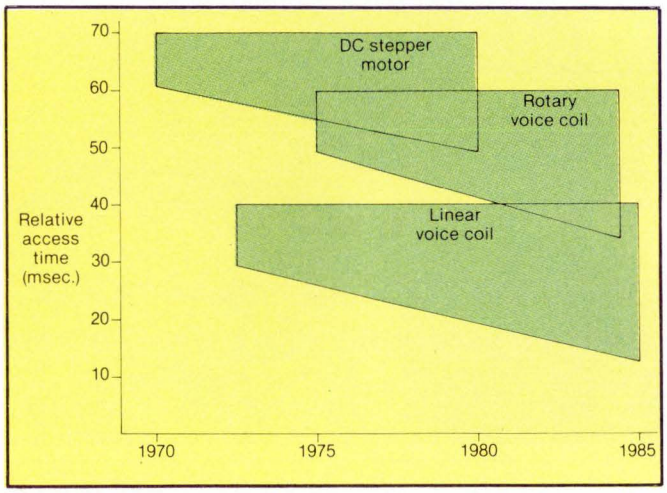
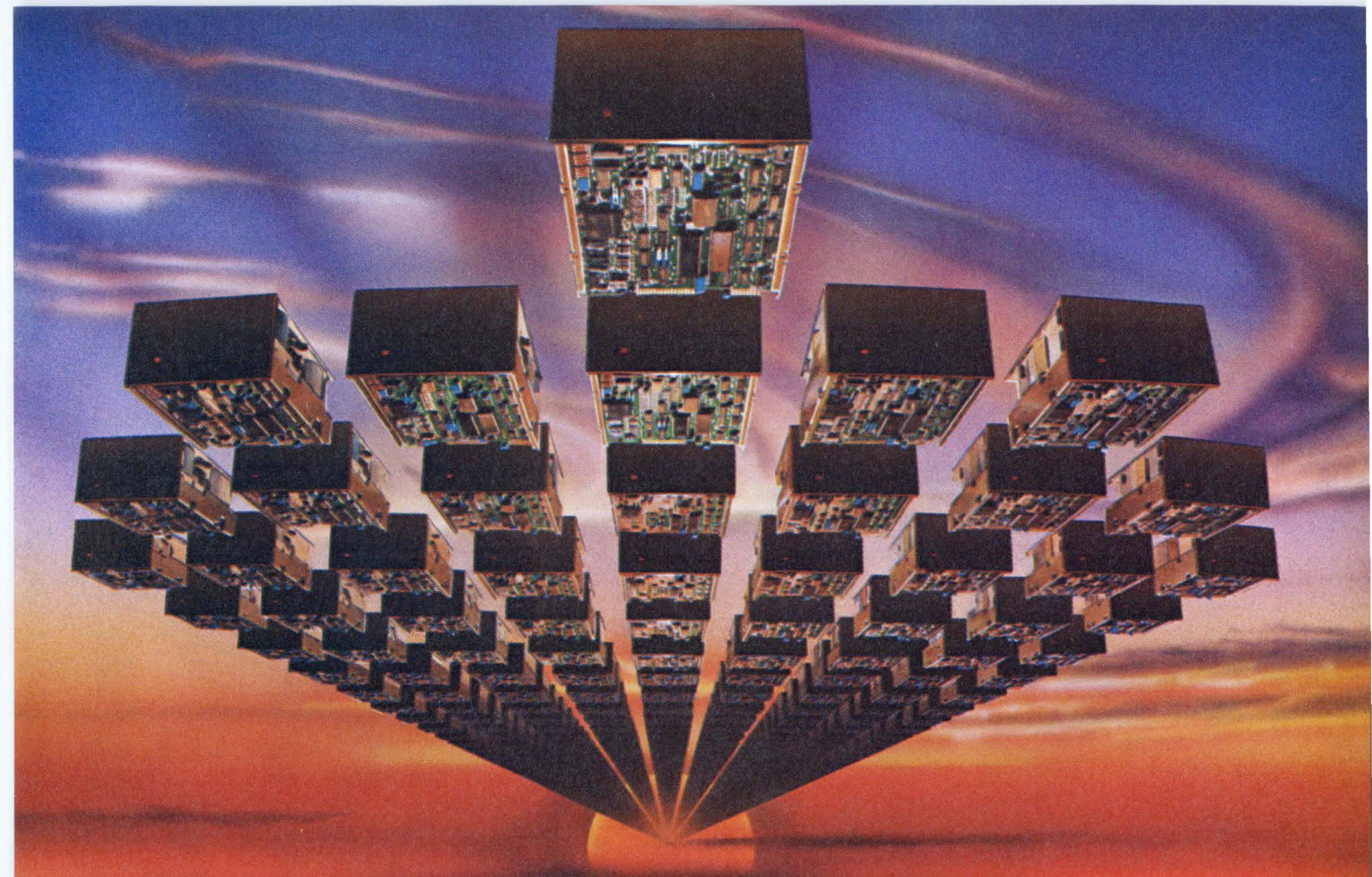


Fig. 3. The speeds and life spans of servo technologies affect their suitability for certain applications. *Stepper-motor disk drives are generally effective for single-user stations, while voice-coil drives are better for multi-user, multitasking environments.*

Dimension (H × W × L, in.)	Standard products
2.0 × 4.09 × 5.118	3.5-in. floppy (future rigid?)
3.25 × 5.75 × 8.0	5.25-in. rigid (CDC Wren)
4.62 × 8.55 × 14.25	8-in. rigid (CDC Finch)
10.2 × 8.55 × 24.2	9-in. rigid (CDC fixed or removable storage drive)
10.2 × 17.0 × 30	14-in. rigid (CDC storage module drive)

Fig. 4. Size options for disk drives *give system designers configuration flexibility for machines ranging from desk-tops and microcomputers to large minicomputer systems.*



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Reliable bytes, too. You've told us that. By the way you've ordered our high capacity 5¼" Winchester drives. Again and again. By now we've delivered more high capacity drives than any other supplier. And we've increased our production capacity to 2,000 drives a day. Just to accommodate the demand.

But don't worry. It hasn't gone to our head. We're still just as careful of quality as ever. That care has given us the industry's lowest rejection rate. And the highest performance rating.

Whichever capacity you choose — 6MB, 12MB 19MB or 40MB — you can always be confident that the last byte will be as good as the first. Call or write today for complete product and pricing information. 9216 Eton Avenue, Chatsworth, CA 91311
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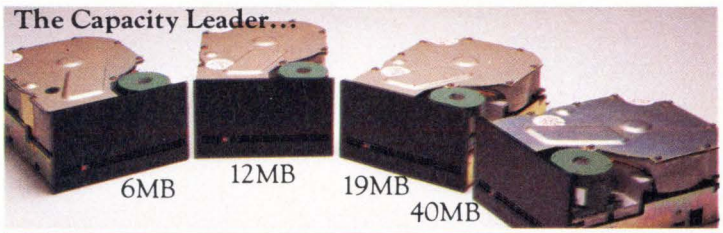

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range of access speeds (Fig. 3). At the slow end is the stepper motor, which is not as expensive as the voice coil, but is also not as fast, accurate or precise. As a rule of thumb, stepper-motor drives perform well with a single-user station (a Z80-based machine, for example), but would degrade if three terminals were added. Rotary voice coils could take over in a multi-user, multitasking environment; however, more than 16 terminals would strain the drive's access rate. Several access requests and more powerful 16-bit machines are best handled by linear voice-coil disk drives. For example, drives with linear actuators are well-suited to UNIX operating systems, which require fast disk access to be efficient. As disks put more data on-line and more users discover a system's new potential, the number of user requests for data increases. Unless the number of accesses has been designed into performance, system throughput will be disappointing at best and a failure at worst.

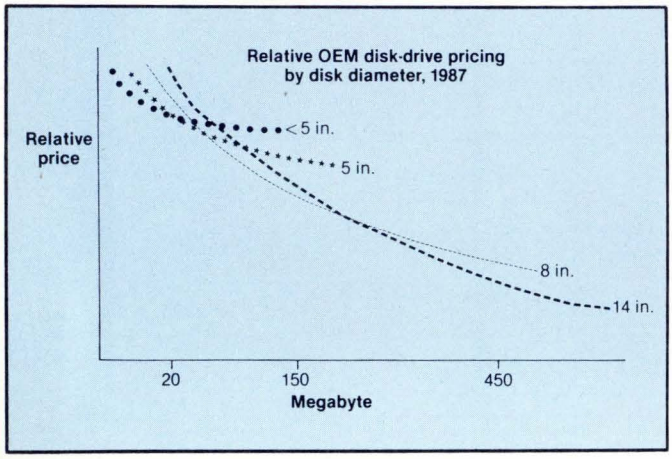


Fig. 5. The greater the storage capacity, the lower the price per megabyte. *This curve is expected to get lower and longer.*

Having estimated access requirements, a disk specifier must consider how much data can be transferred in bursts. If an application demands many consecutive long pages, the designer should set some large buffers and choose a disk with a faster transfer rate. Short pieces of data can tolerate a slower transfer rate, but can slow data accessing.

A drive's intelligence makes performance more efficient by permitting speed matching, local error correction and self diagnostics. The greater the intelli-

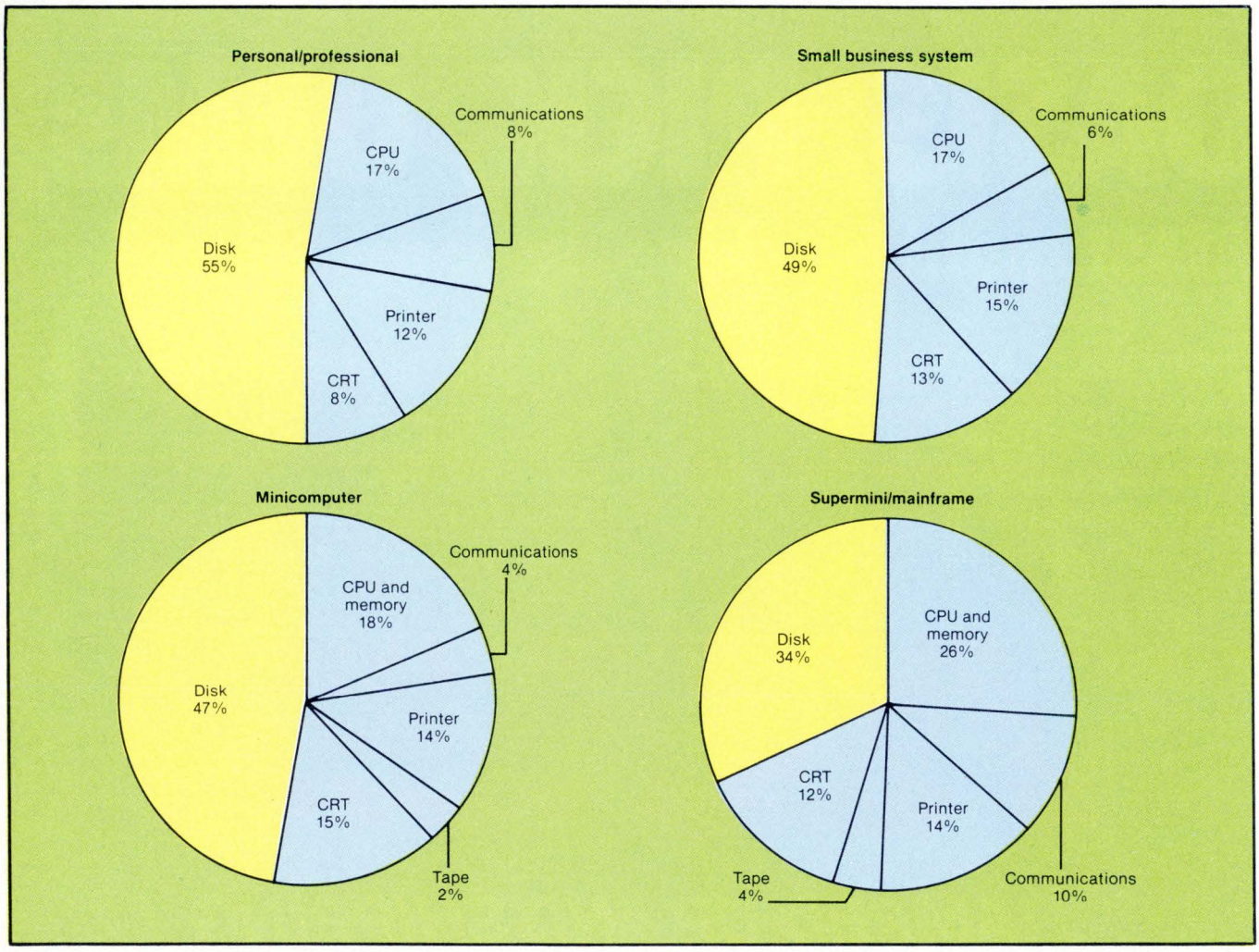
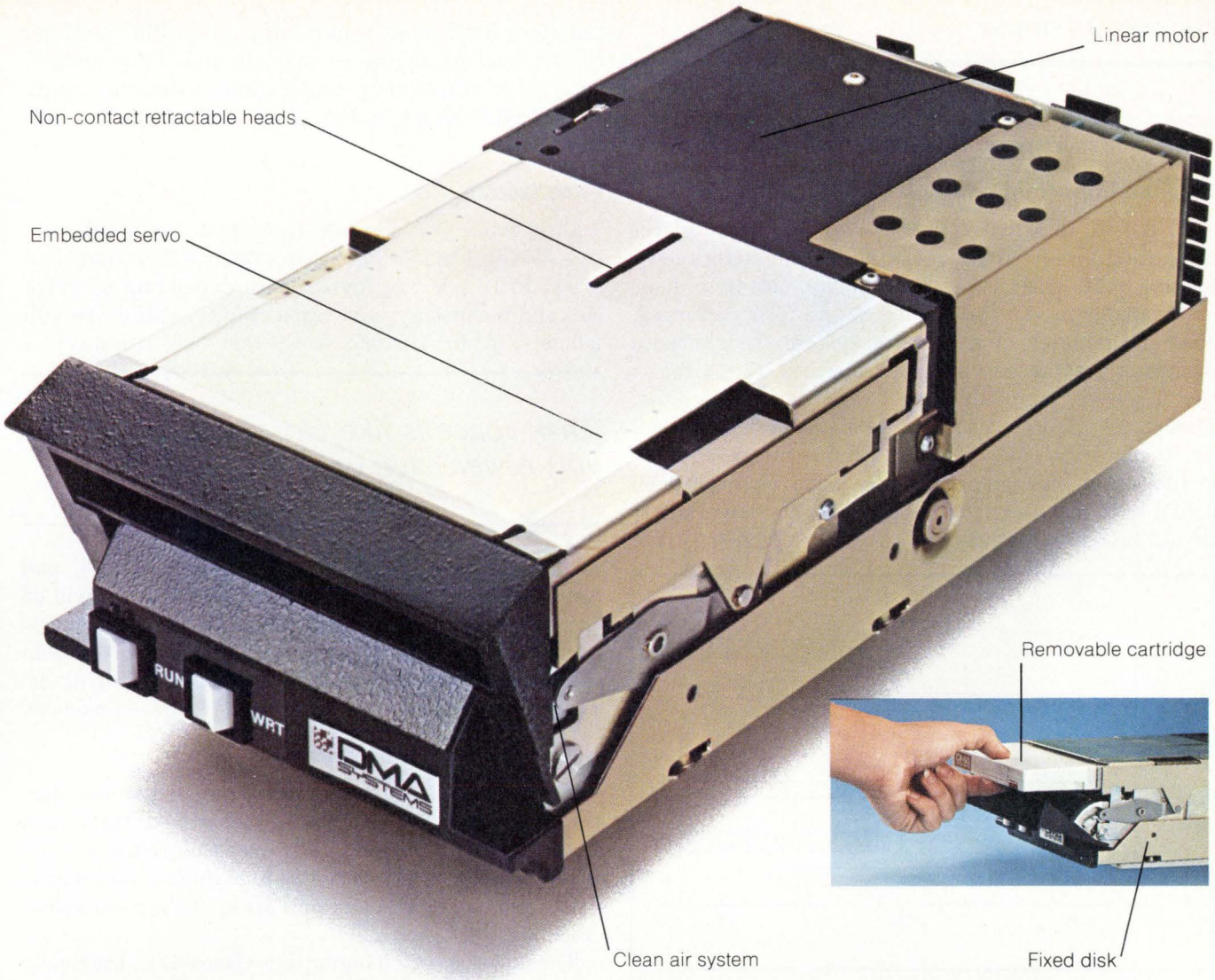


Fig. 6. The most costly component for all computer configurations in 1987 will be disk storage, *according to industry analysts.*



If you think we put all this into our 5¼" cartridge drive for nothing, think again.

In fact, like any good design, if it wasn't deemed absolutely necessary, we didn't put it in. That's something to think about when you examine 5¼" removable-cartridge Winchester drives that leave out these vital features.

We consider an air system that can maintain a Winchester's Class 100 environment a necessity. Even after thousands of cartridge insertions. Not so stiff a requirement when you consider that a particle of dust or cigarette smoke can cause a head crash and result in catastrophic loss of data in your desktop system.

And retractable heads. If the head never, ever touches the media, there's never, ever a chance for damage and data loss. Any other odds should be unacceptable.

And other manufacturers use a stepper motor for positioning. But we won't. Stepper motors are intrinsically less accurate than linear motors. And linear motors provide fast access (40 ms). Stepper motors don't. Our choice was easy.

Same for embedded servo. More accurate, better track following, and part of the system that assures reliable cartridge interchangeability from one drive to another.

Of course there is even more to our story. And if you think we'd send you our color brochure for nothing, you're right.

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gence, the more expensive the drive.

Size: an important criterion

Thanks to distributed data processing, which places computing power on desk tops, disk form factors have become valid selection criteria. Today, 30M-byte disks are available in 14-, 10-, 8-, and 5¼-in. form factors. A smaller diameter disk permits system designers to package the total system in a smaller box. Fig. 4 shows the accepted "standard" hard disk drive box sizes. Exceptions to these box dimensions have been caused by technology and size/performance trade-offs by vendors. For example, if a vendor believes a voice-coil actuator is necessary, he must make his drive larger than if he used stepper-motor actuator technology. On the other hand, if he is designing a desk-top package, the physical packaging constraints allow only smaller capacity drives. Other considerations in determining an appropriate size are special power and cooling requirements.

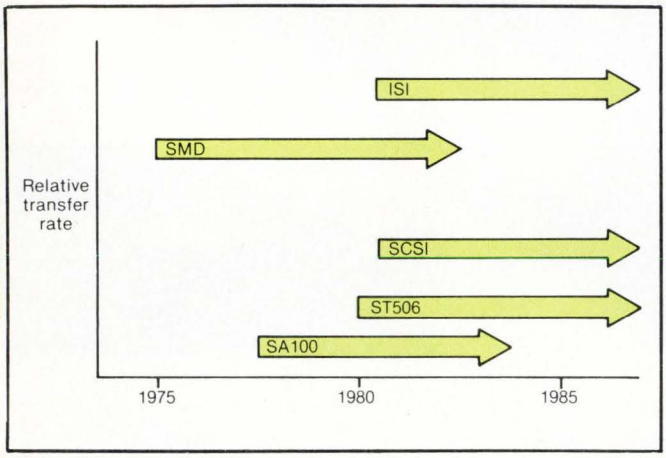
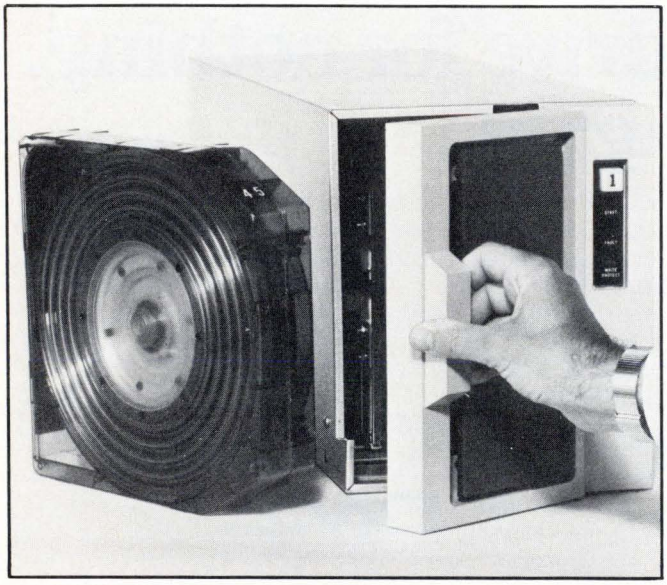


Fig. 7. Emerging interface standards should be considered when selecting a disk drive. *The best choice is the interface that accommodates the greatest range of transfer rates and types of peripherals.*



CDC's 9710 removable storage drive *uses a front-loading, 8-in. data pack, stores as much as 8M bytes of data and incorporates an SMD interface.*

Price factors

Disk drive prices range from $170 for a sub-5-in. (e.g., 3½-in.) unit to more than $100,000 for a 1.5G-byte drive. Price per megabyte varies depending on drive size and technology, and price/capacity ratios are still falling (Fig. 5). History shows that disk storage is a major cost contributor to total system prices, and Control Data Corp. estimates that disk storage will be the most expensive part of minicomputer and microcomputer systems of all sizes by 1987 (Fig. 6). A system integrator's projected end-user prices should determine what he pays for a rigid disk storage component.

'Disk space is like closet space; you never have enough.'

Users want standard interfaces

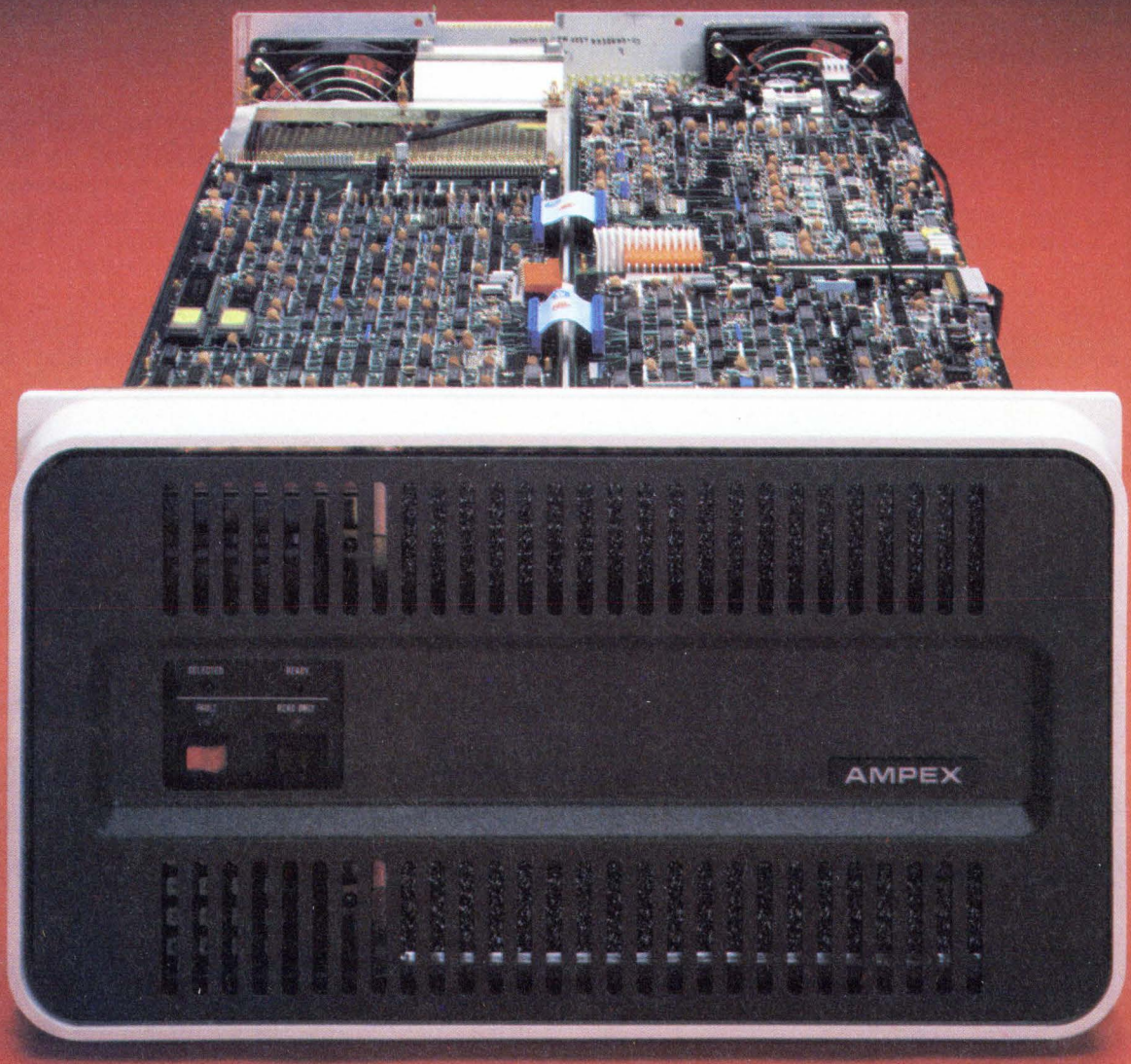
Computer users are pressuring disk drive manufacturers for interface standards. Standard rigid disk interfaces have evolved slowly over the past few years to the point at which three or four de facto standards exist, and two or three others are becoming standards (Fig. 7).

The expense of changing interfaces can drastically affect software and controller development costs. A system integrator should choose an interface to meet performance factors—one that accommodates new technologies and has the flexibility to cover a broad range of drives.

Although eventually fewer interface standards will accommodate more types of peripherals, current standards are limited to specific classes of storage media. CDC's Intelligent Standard Interface attaches peripherals with speeds from 10M to 50M bits per sec. It is superseding CDC's Storage Module Drive interface. The Standard Committee Standard Interface is the upgraded Shugart Associates System Interface, accepted and renamed by the American National Standards Institute. SCSI attaches high-performance rigid 5¼-in. disk drives with transfer rates of approximately 7M bps. The Seagate Technology Corp. ST506 also supports 5¼-in. drives but at 5M bps, while Shugart Associates' SA1000 is the standard for floppies. □

Grover Mullin is general manager, OEM marketing requirements, at Control Data Corp., Minneapolis, Minn.

FREE TEST DRIVE



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8-IN. AND LARGER FIXED DISKS

Company Model	Disk diameter 14-in. (Y/N)	10½-in. (Y/N)	8-in. (Y/N)	Capacity (M bytes)	Avg. access time (msec.)	Transfer rate (K bytes/ sec.)	No. of data surfaces	Bytes/ track	Actuator type
ADVANCED ELECTRONICS DESIGN									
Winc08	N	N	Y	46.8	70	219	0	0	
ALPHA DATA, INC.									
Atlas	Y	N	N	128	23	1250	5	20160	servo rotary
AMPEX CORP.									
SCORPIO-48	N	N	Y	49.7	32	1200	3	20160	linear voice coil
SCORPIO-80	N	N	Y	82.9	32	1200	5	20160	linear voice coil
CAPRICORN 165	Y	N	N	165.9	30	1200	5	20160	linear voice coil
CAPRICORN 165E	Y	N	N	165.9	30	1200	5	20160	linear voice coil
CAPRICORN 330	Y	N	N	330.3	30	1200	8	20160	linear voice coil
APPLIED PERIPHERAL SYSTEMS, INC.									
4830-1/4835-1	Y	N	N	202.2	25		3	40960	linear
4830-3/4835-3	Y	N	N	404.5	25		6	40960	linear
4830-2/4835-2	Y	N	N	337.1	25		5	40960	linear
ATASI CORP.									
3020	N	N	Y	19.84	30		3	10417	linear voice coil
3033	N	N	Y	33.1	30		5	10417	linear voice coil
3046	N	N	Y	46.3	30		7	10417	linear voice coil
CENTURY DATA SYSTEMS, INC.									
C2048	N	Y		34.2	30	1209	6	20160	voice coil
CONTROL DATA CORP.									
CDC 9410 Finch	N	N	Y	8	42	800	1	10416	rotary voice coil
CDC 9410 Finch	N	N	Y	24	42	800	3	10416	rotary voice coil
CDC 9410 Finch	N	N	Y	32	42	800	4	10416	rotary voice coil
CDC 9410 Finch	N	N	Y	40	42	800	5	10416	rotary voice coil
CDC 9410-1K Finch	N	N	Y	24.8	42	6.00	4	10416	rotary voice coil
CDC 9410-1K Finch	N	N	Y	31.0	42	6.00	5	10416	rotary voice coil
CDC 9730 mini module drive	Y	N	N	80	30	1200	3	20160	rotary voice coil
CDC 9730 mini module drive	Y	N	N	160	30	1200	5	20160	rotary voice coil
CDC 9775 fixed module drive	Y	N	N	679	25	1200	20	20160	linear voice coil
CDC 9715 fixed storage drive	N	N	N	160	30	1200	10	20672	rotary voice coil

Interface type	Price ($)	Special features
	9430	DEC RLO2 emulation
SMD, ANSI	600, Q100	cobalt-plated, retractable head, brushless DC motor
SMD or ANSI	3810	functional testing during power-up, no maintenance or adjustment
SMD or ANSI	4870	functional testing during power-up, no maintenance or adjustment
SMD	7715	functional testing during power-up, on-board diagnostic routines
SMD	7715	functional testing during power-up, on-board diagnostic routines
SMD	10730	functional testing during power-up, on-board diagnostic routines
SMD		thin-film heads, self-test, RLL recording, micro-based
SMD		thin-film heads, self-test, RLL recording, micro-based
SMD		thin-fiim heads, self-test, RLL recording, micro-based
ST-506	1470, Q1000	closed-loop servo, double isolation, shock mounting
ST-506	1800, Q1000	closed-loop servo, double isolation, shock mounting
ST-506	2150, Q1000	closed-loop servo, double isolation, shock mounting
SMD	3000, Q100	
FDI/LDI/ISI/SMD	1350, Q500	variable sectoring, integral data recovery, sealed module
FDI/LDI/ISI/SMD		variable sectoring, integral data recovery, sealed module
FDI/LDI/ISI/SMD		variable sectoring, integral data recovery, sealed module
FDI/LDI/ISI/SMD	2040, Q500	variable sectoring, integral data recovery, sealed module
SAIXXX	1625, Q500	variable sectoring, sealed module
SAIXX	1920, Q500	
SMD	4515, Q500	sealed data module, integral power supply
SMD	5180, Q500	sealed data module, integral power supply
SMD	14860, Q500	sealed data module, internal diagnostics
SMD compati ble	4600, Q250-499	9-in., fixed/variable sectoring, dual channel access

8-IN. AND LARGER FIXED DISKS

Company Model	Disk diameter 14-in. (Y/N)	10½-in. (Y/N)	8-in. (Y/N)	Capacity (M bytes)	Avg. access time (msec.)	Transfer rate (K bytes/ sec.)	No. of data surfaces	Bytes/ track	Actuator type
COMPUTER DYNAMICS									
OEM Disk	N	N	Y	5.3	52	540	2		band
CORVUS SYSTEMS, INC.									
20MB	N	N	Y	20.5	35	648	5	10800	linear voice coil
11MB	N	N	Y	11.3	35	648	3	10800	linear voice coil
CYNTHIA PERIPHERAL CORP.									
D160-4	N	Y	N	73	40	920	4	12800	linear voice coil
D160-6	N	Y	N	109	40	920	6	12800	linear voice coil
D160-8	N	Y	N	145	40	920	8	12800	linear voice coil
D165	N	Y	N	73	40	920	4	12800	linear voice coil
D165	N	Y	N	109	40	920	6	12800	linear voice coil
D165	N	Y	N	145	40	920	8	12800	linear voice coil
DATA GENERAL CORP.									
6160	Y	N	N	73	38	1209	3	17920	
6161	Y	N	N	147	38	1209	5	17920	
6214	Y	N	N	675	38	1209	20	0	
DICOM INDUSTRIES, INC.									
604	Y	N	N	29	90		4	10417	
DIGITAL DEVELOPMENT CORP.									
530M	Y	N	N	11		1375	4	11500	fixed
750	Y	N	N	4.8		1125	2	18750	fixed
800	Y	N	N	9.6		1125	2	18750	fixed
M6000	Y	N	N	4.8		18750	2	18750	pneumatic
DISCTRON									
DP-400	N	N	Y	46.4		875	4	13	voice coil
HARRIS CORP.									
5650/5651 storage module	Y	N	N	300 removable	38	1209	19	20160	linear voice coil
5660/5661	Y	N	N	675	33	1209	20	20160	linear voice coil
5330/5331	Y	N	N	80	36	1209	5	20160	linear voice coil
5350/5351	Y	N	N	160	36	1209	5	20160	linear voice coil
5630/5631 storage module	Y	N	N		36	1209	5	20160	linear voice coil
HIGHTRACK COMPUTER TECHNIK GMBH									
HT160	N	N	Y	160	30		10	0	
HT80	N	N	Y	80	30		5	20160	rotating
IBIS SYSTEMS, INC.									
5380 A-2, B-2	Y	N	N	1409	16	3000	16	19120	linear
A-4	Y	N	N	2818	16	3000	32	19120	linear
B-4	Y	N	N	2818	16	3000	32	19120	linear

Interface type	Price ($)	Special features
many	1100	WD-1000-80 intelligent controller
parallel	5995	6-mo. warranty
various	4995	6-mo. warranty
C2I	3160, Q100	
C2I	3440, Q100	
C2I	3720, Q100	
C2I		SASI, intelligent interface
C2I		SASI, intelligent interface
C2I		SASI, intelligent interface
Data General	18000	
Data General	24000	
Data General	5000	
HP 21XX/1000	13000	7½-in. rack mount
many		head-per-track, militarized
many		head-per-track
many		head-per-track
many		head-per-track, ruggedized
parallel	1540, Q1000	
SMD	34250	565D has universal disk controller; $9400
SMD	40000	5660 has universal disk controller; $8000
SMD	14500	5330 has universal disk $7400
SMD	20900	5350 has controller; $7400
SMD	20500	5630 has controller; $6400
SMD		
IBM, SMD		single port, thin-film media
IBM, SMD	97650	single port, thin-film media
IBM, SMD	81000	single port, thin-film media

8-IN. AND LARGER FIXED DISKS

Company Model	Disk diameter 14-in. (Y/N)	10½-in. (Y/N)	8-in. (Y/N)	Capacity (M bytes)	Avg. access time (msec.)	Transfer rate (K bytes/ sec.)	No. of data surfaces	Bytes/ track	Actuator type
IBM CORP.									
3310A1	N	N	Y	64.5	27	1031	11	16384	rotary
3310A2	N	N	Y	64.5	27	1031	11	16384	rotary
3310B1	N	N	Y	64.5	27	1031	11	16384	rotary
3310B2	N	N	Y	64.5	27	1031	11	16384	rotary
3344B2	Y	N	N	280	25	885	15	8368	linear radial
3344B2F	Y	N	N	280	25	885	15	8368	linear radial
3350A2	Y	N	N	635	25	1198	15	19069	linear radial
3350A2F	Y	N	N	635	25	1198	15	19069	linear radial
3350B2	Y	N	N	635	25	1198	15	19069	linear radial
3370A1	Y	N	N	571.3	20	1859	12	0	linear
3370B1	Y	N	N	571.3	20	1859	12	0	linear
3375A1	Y	N	N	819.7	19	1859	12	0	linear
3380AA4	Y	N	N	1520	16	3000	15	47476	linear
3380B4	Y	N	N	1520	16	3000	15	47476	linear
INTERNATIONAL MEMORIES, INC.									
7710	N	N	Y	12.6	35	648	3	10800	linear voice coil
7720	N	N	Y	21	35	648	5	10800	linear voice coil
7740	N	N	Y	42	50	648	5	10800	linear voice coil
8470	N	N	Y	42	35	648	5	10800	linear voice coil
8760	N	N	Y	57	35	648	7	10800	linear voice coil
KENNEDY CO.									
53160	Y	N	N	165	30	1000	5	20160	rotary voice coil
5380	Y	N	N	82	30	1000	5	160	rotary voice coil
6172	N	N	Y	24.5	40	800	3	13344	linear voice coil
6173	N	N	Y	40.9	40	800	5	13344	linear voice coil
7340	N	N	Y	41.4	30	1209	5	20160	rotary voice coil
7380	N	N	Y	82.9	30	1209	5	20160	rotary voice coil
MEGAVAULT									
MV116	N	N	Y	116.1	45	1209	7	20160	rotary voice coil
MV20L	N	N	Y	20.4	45	625	3	10416	rotary voice coil
MV25L	N	N	Y	25.7	45	625	3	10416	rotary voice coil
MV26	N	N	Y	26.6	45	812	3	13545	rotary voice coil
MV34L	N	N	Y	34.1	45	625	5	10416	rotary voice coil
MV42L	N	N	Y	42.8	45	625	5	10416	rotary voice coil
MV44	N	N	Y	44.4	45	812	5	13545	rotary voice coil
MV48	N	N	Y	49.7	45	1209	3	20160	rotary voice coil
MV48L	N	N	Y	47.8	45	625	7	10416	rotary voice coil
MV60L	N	N	Y	60.0	45	625	7	10416	rotary voice coil

Interface type	Price ($)	Special features
	14280	fixed-block architecture, single-drive control
	23730	fixed-block architecture, 2 drives, control
	11300	fixed-block architecture, attaches to 3310A
	20750	fixed-block architecture, 2 drives, attaches to 3310A
	41600	
	43250	has 1M-byte fixed-head capacity
	41600	
	51910	has 1M-byte fixed-head capacity
	32940	CKD, attaches to 3350A
	44350	fixed-block architecture, 2 actuators, control
	29550	fixed-block architecture, 2 actuators, attaches to 3370A1
	50720	2 actuators, control
	116050	4 actuators, 2 controllers for dynamic path selection
	84240	4 actuators, attaches to 3380 or AA4
ANSI or IMI	1775 (OEM)	
ANSI or IMI	2090 (OEM)	
ANSI or IMI	2490 (OEM)	
ANSI or IMI	2490 (OEM)	full shock mounts
ANSI or IMI	2690 (OEM)	full shock mounts
SMD, Pico	4625, Q100	power supply, slides, terminator
SMD, Pico	3700, Q100	power supply, slides, terminator
SMD, ANSI, disk bus	1895, Q100	
SMD, ANSI, disk bus	2195, Q100	
SMD, ANSI, Pico bus	2560, Q100	
SMD, ANSI, Pico bus	3195, Q100	
SMD or ANSI	2900, Q500	aluminum casting, AC/DC, status display, closed air
SA1000/ST-512	1800, Q500	aluminum casting, AC/DC, status display, closed air
SA1000/ST-512	1990, Q500	aluminum casting, AC/DC, status display, closed air
SMD or ANSI	1990, Q500	aluminum casting, AC/DC, status display, closed air
SA1000/ST-512	1995, Q500	aluminum casting, AC/DC, status display, closed air
SA1000/ST-512	2200, Q500	aluminum casting, AC/DC, status display, closed air
SMD or ANSI	2200, Q500	aluminum casting, AC/DC, status display, closed air
SMD or ANSI	2480, Q500	aluminum casting, AC/DC, status display, closed air
SA1000/ST-512	2190, Q500	aluminum casting, AC/DC, status display, closed air
SA1000/ST-512	2390, Q500	aluminum casting, AC/DC, status display, closed air

8-IN. AND LARGER FIXED DISKS

Company Model	Disk diameter 14-in. (Y/N)	10½-in. (Y/N)	8-in. (Y/N)	Capacity (M bytes)	Avg. access time (msec.)	Transfer rate (K bytes/sec.)	No. of data surfaces	Bytes/track	Actuator type
MV62	N	N	Y	62.1	45	812	7	13545	rotary voice coil
MV83	N	N	Y	82.9	45	1209	5	20160	rotary voice coil
MICROPOLIS CORP.									
1202ANSI	N	N	Y	26.8	42	922	3	15364	voice coil
1202SA	N	N	Y	20.6	42	922	3	15364	voice coil
1203ANSI	N	N	Y	44.6	45	542	5	10416	voice coil
1203SA	N	N	Y	34.3	45	542	6	10416	voice coil
1221	N	N	Y	8.9	42	922	1	15364	voice coil
1222	N	N	Y	26.7	42	922	2	15364	voice coil
1223	N	N	Y	44.6	42	922	3	15364	voice coil
1400ANSI	N	N	Y	100/200	28	1248	0	20800	voice coil
1400SA	N	N	Y	50/100	28	542	0	10416	voice coil
1400SMD	N	N	Y	80/160	26	1200	0	20160	voice coil
1420	N	N	Y	74/148	28	922	0	15364	voice coil
MITSUBISHI ELECTRONICS AMERICA, INC.									
M2860-1	N	N	Y	21.7	35	806	3	13440	linear motor
M2860-2	N	N	Y	50.7	35	806	7	13440	linear motor
NATIONAL MEMORY SYSTEMS CORP.									
160ION	Y	N	N	160	60	1200	5		fixed
474	Y	N	N	474	17	1860	10		
84	N	N	Y	84	40	1200	7		fixed
NEC INFORMATION SYSTEMS, INC.									
D1510	Y	N	N	331.5	20	1200	15	20480	linear voice coil
D1550	Y	N	N	663	20	1200	15	20480	linear voice coil
D2230	N	N	Y	42.5	30	1200	5	20480	rotary voice coil
D2246	N	N	Y	85.0	25	1200	6	20480	rotary voice coil
PRIAM CORP.									
1070	N	N	Y	11	73	900	4	15151	stepper motor
3450	N	N	Y	35	42	800	5	13440	linear voice coil
7050	N	N	Y	70	42	800	5	13440	linear voice coil
804	N	N	Y	105	42	1200	5	20160	linear voice coil
Diskos 15450	Y	N	N	158	40	1040	3	20160	linear voice coil
Diskos 3350	Y	N	N	34	45	1040	1	20160	linear voice coil
Diskos 6650	Y	N	N	68	45	1040	1	20160	linear voice coil
QUANTUM CORP.									
Q2010	N	N	Y	10.7	55	542	2	8192	rotary torque
Q2020	N	N	Y	21.3	60	542	4	8192	rotary torque
Q2030	N	N	Y	32	60	542	6	8192	rotary torque
Q2040	N	N	Y	42.66	65	542	8	8192	rotary torque

Interface type	Price ($)	Special features
SMD or ANSI	2390, Q500	aluminum casting, AC/DC, status display, closed air
SMD or ANSI	2690, Q500	aluminum casting, AC/DC, status display, closed air
ANSI X3T9.3		
SA1100		
ANSI X3T9.3		
SA1100		
ANSI X3T9.3		
SA1100		
SMD		
Micropolis intelligent		
SMD	2200, Q100	DC brushless, direct-drive motor, IC amplifier built into each head
SMD	2650, Q100	LSI micro-based system performs RAS, others
SMD		slide racks, front panel
fixed		slide racks, front panel
SMD		slide racks, front panel
SMD	9800, Q100	
SMD	13500, Q100	
SMD	2850, Q100	
SMD	3300, Q100	AM detect, mounting frame, term resistors
Priam, SMD, ANSI	1315, Q500	on-board data separator
Priam, SMD, ANSI	1950, Q500	DC motor, data separator, common interface with 14-, 5¼-in. drives
Priam, SMD, ANSI	2720, Q500	DC motor, data separator, common interface with 14-, 5¼-in. drives
Priam, SMD, ANSI	3300, Q500	DC motor, data separator, common interface with 14-, 5¼-in. drives
Priam, SMD, smart	3440, Q500	DC motor, data separator, common interface with 8-, 5¼-in. drives
Priam, SMD, smart	1680, Q500	DC motor, data separator, common interface with 8-, 5¼-in. drives
Priam, SMD, smart	2235, Q500	DC motor, data separator, common interface with 8-, 5¼-in. drives
Q2000/SA1000	1200, Q500	
Q2000/SA1000	1500, Q500	
Q2000/SA1000	1800, Q500	
Q2000/SA1000	2100, Q500	

8-IN. AND LARGER FIXED DISKS

Company Model	Disk diameter 14-in. (Y/N)	10½-in. (Y/N)	8-in. (Y/N)	Capacity (M bytes)	Avg. access time (msec.)	Transfer rate (K bytes/ sec.)	No. of data surfaces	Bytes/ track	Actuator type
SCIENTIFIC MICRO SYSTEMS									
FWT series	N	N	Y	8.9	65	543	0	0	
SHUGART ASSOCIATES									
SA4004	Y	N	N	14.5	65	9000	2	0	band
SA1002	N	N	Y	5.3	52	540	2	0	band
SA1004	N	N	Y	10.7	52	540	4	0	band
SA1104	N	N	Y	20.3	35	540	4	0	closed loop servo
SA1106	N	N	Y	33.9	35	540	6	0	closed loop servo
SA4008	Y	N	N	29	65	9000	4	0	band
STORAGE TECHNOLOGY CORP.									
8654	Y	N	N	1346	23	1198	30	19969	linear voice coil
8775	Y	N	N	673	23	1198	15	19969	linear voice coil
SYSTEM INDUSTRIES									
	Y	N	N	675	30	1200	19	0	
	N	Y	N	475	25	1900	0	0	
	N	Y	N	160	30	1000	0	0	
TANDON CORP.									
TM703	N	N	Y	31	39		5	1300	rotary/voice control
TECSTOR, INC.									
S-165	Y	N	N	165.9	29		5	20160	
S-200	Y	N	N	199.1	29		6	20160	
S-300	Y	N	N	315.2	30		9	20160	
S-330	Y	N	N	331.8	30		9	20160	
S-85	Y	N	N	82.9	29		3	20160	
3M DATA RECORDING PRODUCTS									
8432	N	N	Y	20	75	933	4	17920	
8431	N	N	Y	10	75	933	2	17920	stepper, band actuated, rotary
8533	N	N	Y	60	39	933	4	17920	voice coil rotary
WANG LABORATORIES, INC.									
2265V-3	Y	N	N	675	25	1200	20	20160	linear voice coil

Interface type	Price ($)	Special features
	6900	includes 1.2M-byte floppy disk drive
	1600, Q200	
SA801/851	1140, Q200	
SA801/851	1400, Q200	
SA1000	1920, Q200	
SA1000	2300, Q200	
	2000, Q200	
native interface	32125, Q100	
ANSI/SMD	13786, Q100	diagnostics, micro-controlled adjustment
SMD	25000	dual-channel optional, self-test
SMD	16500	dual-channel standard
SMD	9000	dual-channel optional
ST-506	1950	600 tpi, on-board MPU, closed-loop
SMD	5450, Q100	
SMD	6000, Q100	
SMD	6551, Q100	
SMD	6551, Q100	
SMD	4899, Q100	
ANSI 1226	1735, Q100	modularity permits migration from 10M to 240M bytes, air filtration
ANSI 1226	1525, Q100	modularity permits migration from 10M to 240M bytes, air filtration
ANSI 1226	3380, Q100	modularity permits migration from 10-240MB, air filtration
SMD	38000	

5¼-IN. FIXED DISKS

Company Model	Capacity (M bytes)	Avg. access time (msec.)	Transfer rate (K bits/sec.)	No. of data surfaces	Bytes/track	Actuator type	Interface type	Price ($)	Special features
ADVANCED ELECTRONIC DESIGN, INC.									
Winc05	6.4	93	259					5033	DEC RX02 and RL01/02 emulation
AMPEX CORP.									
PYXIS 7	6.7	90	625	2	10417	Rotational	ST506	930	temperature compensated head positioning, automatic stepper motor lock
PYXIS 13	13.3	90	625	4	10417	Rotational	ST506	1095	temperature compensated head positioning, automatic stepper motor lock
PYXIS 20	20	90	625	6	10417	Rotational	ST506	1325	temperature compensated head positioning, automatic stepper motor lock
PYXIS 27	26.7	90	625	8	10417	Rotational	ST506	1540	temperature compensated head positioning, automatic stepper motor lock
BASF AG									
6183	9.6	61							brushless DC motor
6184	14.4	92							brushless DC motor
COMPUTER MEMORIES, INC.									
CM5206	6.4	72	625	2	10400	open loop stepper	ST-506	650, Q1000	on-board micro, manganese-zinc heads
CM5412	12.8	72	625	4	10400	open loop stepper	ST-506	775, Q1000	
CM5619	19.1	72	625	6	10400	open loop stepper	ST-506	990, Q1000	
CM5640	40	40	625	6	10400	closed loop servo	ST-506	1320, Q1000	closed loop servo positioning system, on-board micro
CONTROL DATA CORP.									
CDC 9415-3 "wren"	19	50	600	3	10080	rotary voice coil	FDI/LDI/ISI	1150, Q1000	integral data recovery, LSI circuits, variable sectoring
CDC 9415-3 "wren"	32	50	600	5	10080	rotary voice coil	FDI/LDI/ISI	1150, Q1000	integral data recovery, LSI circuits, variable sectoring
CDC 9415-5 "wren"	19	50	625	3	10080	rotary voice coil	ST5XX	1450, Q1000	LSI circuits, variable sectoring
CDC 9415-5 "wren"	32	50	625	5	10080	rotary voice coil	ST5XX	1450, Q1000	LSI circuits, variable sectoring
CORVUS SYSTEMS, INC.									
6MB	6.7	125	960	4	12000	steel band	various	3195	6-mo. warranty
DISCTROM									
RMS507	6.4	77	625	2	10417	rotary	ST-412	805, Q100	buffered seek mode, 19.4 W
RMS514	12.8	77	625	4	10417	rotary	ST-412	935, Q100	buffered seek mode, 19.4 W
RMS526	25.5	77	625	8	10417	rotary	ST-412	1365, Q100	buffered seek mode, 19.4 W
EVOTEK CORP.									
ET-5500	31.2	49	625	8	8192	linear band	ST-506	1650, Q1000	thin-film media, 5-phase stepper motor
ET-5800	51.6	49		8	16328	linear band	ST-506	2225, Q1000	thin-film media, 5-phase stepper motor
HEWLETT-PACKARD CO.									
9134A	4.6	173	50		7680				

Company Model	Capacity (M bytes)	Avg. access time (msec.)	Transfer rate (K bits/ sec.)	No. of data surfaces	Bytes/ track	Actuator type	Interface type	Price ($)	Special features
INTERNATIONAL MEMORIES, INC.									
5006		68	625	2	8192	stepper	ST-412	625, Q1000	shocks, plated media, head-mounted preamp
5012		68	625	4	8192	stepper	ST-412	740, Q1000	
5018		68	625	6	8192	stepper	ST-412	850, Q1000	
IRWIN/OLIVETTI, INC.									
HD 562/13	11.3	66	625	6	10417	stepper motor	ST-506	900, Q500	1.1-msec. track-to-track access
HD-561	7.5	120	625	4	10417	stepper motor	ST-506	660, Q500	
HD-562/11	3.8	66	625	2	10417	stepper motor	ST-506	630, Q500	1.1-msec. track-to-track access
HD-562/12	7.5	66	625	4	10417	stepper motor	ST-506	740, Q500	1.1-msec. track-to-track access
Irwin 416	16	34	675	2	9952	rotary voice coil	Irwin	1140, Q500	embedded servo
Irwin 510	12.2	33	675	2	9952	rotary voice coil	Irwin	1650, Q500	cartridge tape drive, embedded servo
Irwin 516	16	34	675	2	9952	rotary voice coil	Irwin	1794, Q500	embedded servo, tape cartridge drive
MAXTOR									
XT-1045	47.9	35	625	6	10417	rotary voice coil	ST-506		
XT-1065	67	35	625	8	10417	rotary voice coil	ST-506		
XT-1085	86	35	625	10	10417	rotary voice coil	ST-506		
XT-1105	105	35	625	12		rotary voice coil	ST-506		
MICRO PERIPHERALS, INC.									
Griffin I	12.7	35		4	10416			1675	
MICROPOLIS CORP.									
1302	17.3	38	625	2	10416	voice coil	ST-506		
1303	34.6	38	625	2	10416	voice coil	ST-506		
1304	51.9	38	625	6	10416	voice coil	ST-506		
MINISCRIBE CORP.									
2006/2012	6.4/12.8	85	625	4	8192	rack and pinion	ST-412	675, Q1000	
3006/3010	6.4/10	85	625	2	8192	rack and pinion	ST-412	600, Q1000	half-high drive
4010/4020	10/20	120	625	4	8192	rack and pinion	ST-412	750, Q1000	
MITSUBISHI ELECTRONICS AMERICA, INC.									
M4863-2	6.7	75	625	4	10417	stepper motor	SA600, ST-506	720, Q500	DC brushless direct-drive motor, average latency time: 8.3 msec.
M4863-3	10	75	625	6	10417	stepper motor	SA600, ST-506	850, Q500	spindle clamp and head shipping position clamp mechanism
NEW WORLD COMPUTER CO., INC.									
2/0	2	19	625	1	13000	stepper motor	New World	496, Q500	
4/0	4	19	625	2	13000	stepper motor	New World	756, Q500	
NIPPON ELECTRIC CO., LTD.									
RD-5133	13.3	75	625	8	10416	linear	Seagate type		
POLYMORPHIC SYSTEMS									
HD/18	18	70	625				3995		cabinet, controller, S-100 adapter, cables

Company Model	Capacity (M bytes)	Avg. access time (msec.)	Transfer rate (K bits/ sec.)	No. of data surfaces	Bytes/ track	Actuator type	Interface type	Price ($)	Special features
PRIAM CORP.									
502	50	35	625	7	10416	linear voice coil	ST-506, Priam	2000, Q500	shock mounts, data separator with Priam interface
RODIME PLC									
RO 206	31.5	50	625	6	8192	stepper	ST-506		microprocessor diagnostics, temperature compensation
RO 208	42	50	625	8	8192	stepper	ST-506		microprocessor diagnostics, temperature compensation
RO201	5.3	90	625	2	8192	stepper	ST-506	525, Q1000	microprocessor diagnostics, temperature compensation
RO202	10.5	90	625	4	8192	stepper	ST-506	650, Q1000	microprocessor diagnostics, temperature compensation
RO203	15.8	90	625	6	8291	stepper	ST-506	775, Q1000	microprocessor diagnostics, temperature compensation
RO204	21	90	625	8	8192	stepper	ST-506	895	microprocessor diagnostics, temperature compensation
ROTATING MEMORY SYSTEMS, INC.									
RMS-507	6.4	77	625					935, Q100	optional data separator boosts cap. to 9.5MB
RMS-514	12.8	77	625					1165, Q100	optional data separator boosts cap. to 19.1MB
RMS-	19.1	77	625					1330, Q100	optional data separator boosts cap. to 28.5MB
RMS-526	25.5	77	625					1485, Q100	optional data separator boosts cap. to 38MB
SEAGATE TECHNOLOGY									
ST-406	6.4	85	625	2		band	ST-506		
ST-412	12.8	85	625	4		band	ST-506		
ST-419	19.1	85	625	6		band	ST-506		
ST-506	6.4	170	625	4	10416	band	ST-506		11K-hr. MTBF, DC voltage
SHUGART ASSOCIATES									
SA604	6.7	99	625	4		band		1090, Q200	
SA606	10	99	625	6		band		1275, Q200	
TANDON CORP.									
502	12.8	85	625	4	1300		ST-506	1200, Q680	306 cylinders, 345 tpi, on-board MPU
503	19.2	85	625	6	1300		ST-506	1450, Q795	306 cylinders, 345 tpi, on-board MPU
TM501	6.4	85	625	2	1300		ST-506	950, Q545	306 cylinders, 345 tpi, on-board MPU
TEXAS INSTRUMENTS INC.									
525/122	12.8	100	625				ST-506	1575	
525/61	6.4	100	625				ST-506	1225	
UNITED PERIPHERALS									
UP-9705	6.4	85	625	4	8192	stepper	SASI	2995	error correction, compatible with most small computers
UP9800	6.4	85	625	4	8192	stepper	HPIB	2995	error correction, compatible with most HP computers
VERTEX ELECTRONICS, INC.									
V130	31	30	625	3		rotary voice coil	ST-506		thin film media, manganese-zinc ferrite heads
V150	51.7	30	625	5		rotary voice coil	ST-506		thin film media, manganese-zinc ferrite heads
V170	72.3	30	625	7		rotary voice coil	ST-506		thin film media, manganese-zinc ferrite heads
XCOMP, INC.									
X/BT-16	20	40	625	4		stepper	Xcomp		complete software, power supply, cabinet
X/BT-8	10	40	625	2		stepper	Xcomp		complete software, power supply, cabinet

In 5 1/4" and 8" Winchesters. Disctron has the brightest ideas.

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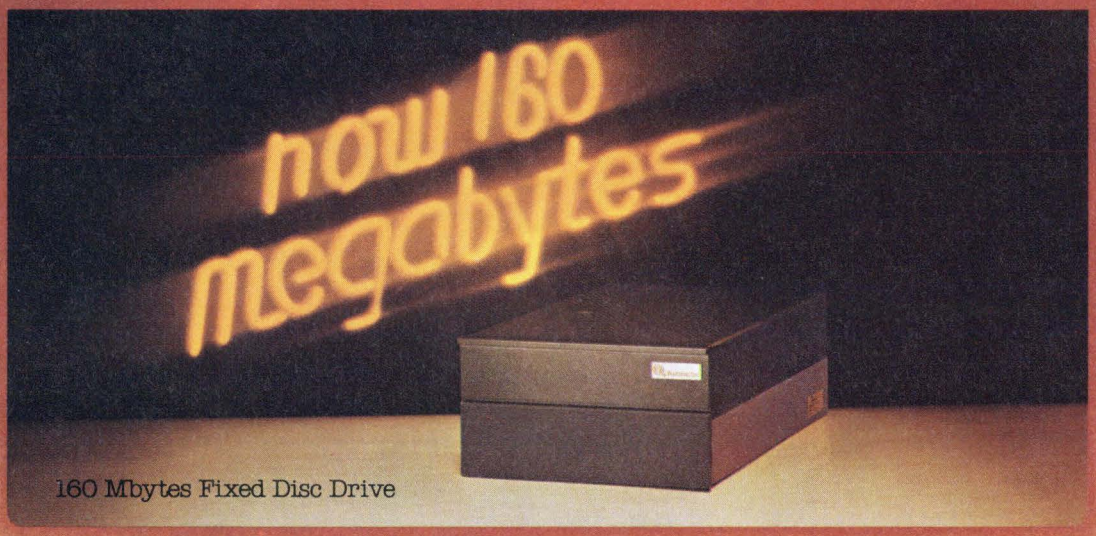
8" Fixed Disc Drive



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European Representative: Micro Memory Systems Ltd., England 635-40405-Tel. 848277 Telex

CARTRIDGE DISKS

Company Model	Disk size 14-in.	10½-in.	8-in.	5¼-in.	Fixed capacity (unformatted, M bytes)	Removable capacity	Avg. access time (msec.)	Transfer rate (K bytes/sec.)	No. of data surfaces	Bytes/ track
ADVANCED ELECTRONICS DESIGN, INC.										
Win08/Flex02	N	N	N	Y	23.4	1.0	70	219	0	0
AMPEX										
DFR 932	Y	N	N	N	16	16	30	1209	2	20160
DFR 964	Y	N	N	N	48	16	30	1209	4	20160
DFR 996	Y	N	N	N	80	16	30	1209	6	20160
DM 9200Q	Y	N	N	N		200	28	806	19	13440
DM 9300Q	Y	N	N	N		300	28	1209	19	20160
DM 9300AQ	Y	N	N	N		300	28	1209	19	20160
DM 940	Y	N	N	N		40	28	1209	5	20160
DM 980	Y	N	N	N		80	28	1209	5	20160
BALL COMPUTER PRODUCTS										
BDA 100	Y	N	N	N		103.2	30	1200	5	20160
BDA 160	Y	N	N	N		164.2	30	1200	5	20160
BDA 50	Y	N	N	N		54.7	30	806	5	13440
BDA 80	Y	N	N	N		82.9	30	1200	5	20160
CENTURY DATA SYSTEMS, INC.										
AMS 380					378.5		25	1208	14	32000
M160					161		50	1280	6	32000
M20					20.15		65	960	4	24000
M40					40.32	65	960		24	
M80					80.64		50	960	6	24000
T200/202-SA						208/210	30	806	19	13440
T300/302/306-SA						312/315	30	1209	19	20160
T50-SA					54.7	30	806		13	440
T80/82-SA						82.9	30	1209	5	20160
AMS 315					315		25	1208	19	20160
CONTROL DATA CORP.										
CDC 976X storage module drive	Y	N	N	N		40	30	1208	5	20160
CDC 976X storage module drive	Y	N	N	N		80	30	1208	5	20160
CDC 976X storage module drive	Y	N	N	N		300	30	1208	19	20160
CDC 9710 removable storage drive						82.9	30	1208	5	20672

Actuator type	Interface type	Price ($)	Special features
		8540 1	integral floppy disk drive, DEC RX02, RL02 emulation
linear & rotary	SMD/CMD	4765, Q50-99	Winchester/cartridge, address mark format, 32, 64 or 96 MByte unformatted capac.
linear & rotary	SMD/CMD	5415, Q50-99	Winchester/cartridge, address mark format, 32, 64 or 96 MByte unformatted capac.
linear & rotary	SMD/CMD	6000, Q50-99	Winchester/cartridge, address mark format, 32, 64 or 96 MByte unformatted capac.
linear voice coil	SMD	10390, Q50-99	removable SMD; NRZ, CDC 9766 compat., precompensation circuitry
linear voice coil	SMD	10390, Q50-99	removable SMD; NRZ, CDC 9766 compat., precompensation circuitry
linear voice coil	SMD	10390, Q50-99	823 cylinder removable; NRZ, CDC 9766 compat., dynamic breaking
linear voice coil	SMD	5900, Q50-99	SMD removable, rack slide mount, NRZ to Miller code (MFM)
linear voice coil	SMD	5900, Q50-99	SMD removable, rack slide mount, NRZ to Miller code (MFM)
linear motor	SMD		19-in. rack mount, variable sector sizes
linear motor	SMD		19-in. rack mount, variable sector sizes
linear motor	SMD/Trident		19-in. rack mount, variable sector sizes
linear motor	SMD/Trident		19-in. rack mount, variable sector sizes
linear voice coil	SMD	7760, Q100	
torquer motor	SMD	4050, Q100	
stepper motor	Marksman	1780, Q100	
stepper motor	Marksman	2235, Q100	
torquer motor	SMD	3265, Q100	
linear motor	TTL/SMD	9055, Q100	
linear motor, servo controlled	TTL/SMD	10255, Q100	
linear motor, servo controlled	TTL	5200, Q100	
linear motor	TTL/SMD	5935, Q100	
linear voice coil	SMD/Trident	7000, Q100	dual access; 300M bytes
linear voice coil	SMD	5840, Q500	single or dual channel (9766), integral power supply
linear voice coil	SMD		single or dual channel (9766), integral power supply
linear voice coil	SMD	10945, Q500	single or dual channel (9766), integral power supply
linear voice coil	SMD compat.	4370, Q500	9-in., fixed/variable sectoring, dual channel access

CARTRIDGE DISKS

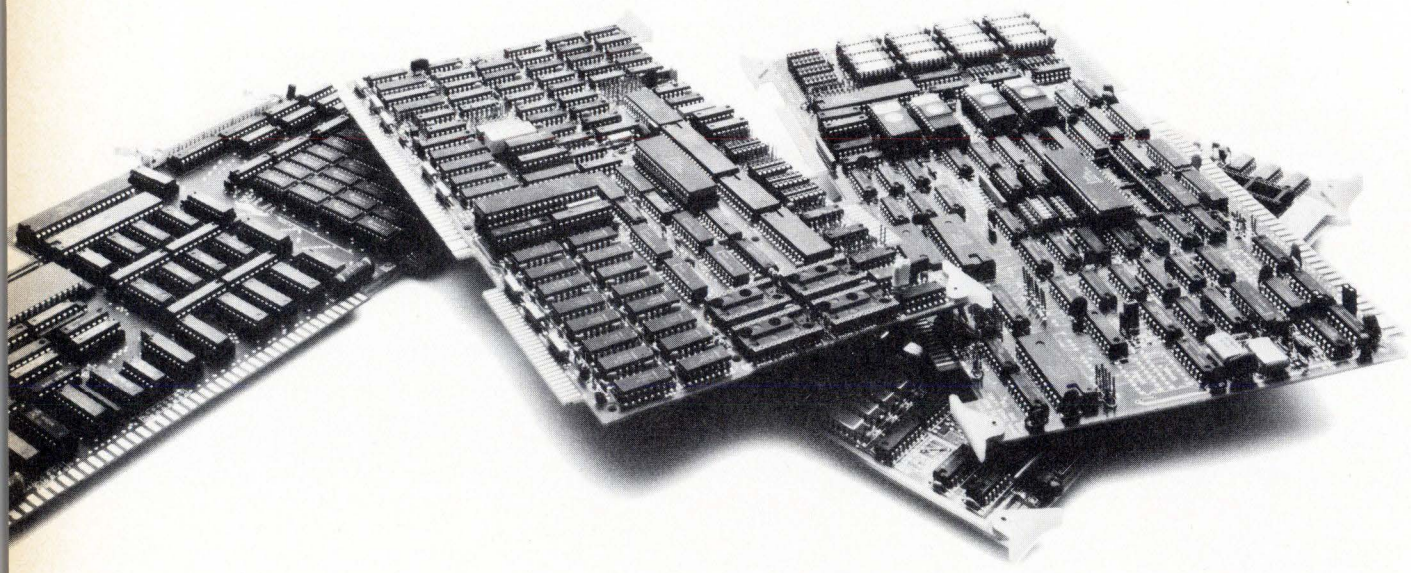
Company Model	Disk size 14-in.	10½-in.	8-in.	5¼-in.	Fixed capacity (unformatted, M bytes)	Removable capacity	Avg. access time (msec.)	Transfer rate (K bytes/sec.)	No. of data surfaces	Bytes/ track
CDC 9455 Lark	N	N	Y	N	8.35	8.35	42	1208	4	20672
CDC 9457 Lark	N	N	Y	N	25	25	35	1208	4	20672
CDC 9427H Hawk	Y	N	N	N	6	6	35	3125	4	7825
DATA GENERAL CORP.										
6060	Y	N	N	N		96	43	806	19	12288
6061	Y	N	N	N		192	43	806	19	12288
6122	Y	N	N	N		277	43	1209	19	17920
DICOM INDUSTRIES										
402	N	N	N	Y	60	6	90		8	10417
DISCTRON										
DP-100	N	N	Y	N		11.6		875	2	13
DMA SYSTEMS CORP.										
Micro-Magnum	N	N	N	Y		6.75	40	625	2	10890
Micro-Magnum 5/5	N	N	N	Y	6.75	6.75	40	625	4	10890
IBM CORP.										
3340A2	Y	N	N	N		140	25	885	12	8368
3340B1	Y	N	N	N		70	25	885	11	8368
3340B2	Y	N	N	N		140	25	885	22	8638
NEC INFORMATION SYSTEMS										
D2220	N	N	Y	N	25.5		30	1200	3	20480
NEW WORLD COMPUTER CO., INC.										
2/2	N	N	N	Y	2	2	19		2	13000
4/2	N	N	N	Y	4	2	19		3	13000
4/4	N	N	N	Y	4	4	19		4	13000
SEAGATE TECHNOLOGY										
ST706	N	N	N	Y		6.4	85	625	2	0
VERMONT RESEARCH CORP.										
5017-4	Y	N	N	N	26.2	26.2	45	673	4	12800
8010	N	N	Y	N		11	33	481	2	8192
8520	N	N	Y	N	11	11	42	481	4	8192
WANG LABORATORIES, INC.										
2260	Y				6.25	6.25	35	497	4	7812
2265V-1	Y	N	N	N		80	30	1200	5	20160
2265V-2	Y	N	N	N		300	30	1200	19	20160
2265V-2B	Y					300		1200	19	20160

Actuator type	Interface type	Price ($)	Special features
linear voice coil	LDI/ISI/SMD	2345, Q500	32 or 64 sectors, integral data recovery, sealed data module
linear voice coil	LDI/ISI/SMD	3070, Q500	32 or 64 sectors, integral data recovery, sealed data module
linear voice coil	CDD	3830, Q500	integral power supply, integral data recovery
	Data General	32250	
	Data General	35900	
	Data General	43350	
	SASI, LSI-11/23	8000	removable Winchester, 5¼-in. rack mount
voice coil	parallel	1390, Q1000	
linear motor	ST-506	1320, Q1000	
linear motor	ST-506	1571, Q1000	
linear radial	2 heads/surface	24570	count-key-data, 2 drives & control
linear radial	2 heads/surface	13510	count-key-data, attaches to 3340A
linear radial		17200	
rotary voice coil	SMD	2375, Q100	
stepper motor	New World	836, Q500	sealed Winchester removable cartridge
stepper motor	New World	996, Q500	sealed Winchester removable cartridge
stepper motor	New World	1196, Q500	sealed Winchester removable cartridge
band	ST-506		
linear	drive level		power supply, data encode/decode, actuator lock, non-contact head
linear	ANSI, SASI, drive level		data encode & separation, non-contact heads
linear	ANSI, SASI, drive level		full data encode & separation, non-contact heads
linear voice coil	Hawk	10700	includes 22C12 disk controller
linear voice coil	SMD	17000	
linear voice coil	SMD	34000	
linear voice coil	SMD	23000	

CARTRIDGE DISKS

Company Model	Disk size 14-in.	10½-in.	8-in.	5¼-in.	Fixed capacity (unformatted, M bytes)	Removable capacity	Avg. access time (msec.)	Transfer rate (K bytes/sec.)	No. of data surfaces	Bytes/ track
2280N-1	Y	N	N	N	16.3	32.6	30	1200	2	20160
2280N-2	Y	N	N	N	16.3	65.2	30	1200	4	20160
2280N-3	Y	N	N	N	16.3	97.3	30	1200	6	20160
2280V-1	Y	N	N	N	16.3	32.6	30	1200	2	20160
2280V-2	Y	N	N	N	16.3	65.2	30	1200	4	20160
2280V-3	Y	N	N	N	16.3	97.7	30	1200	6	20160
6580-1	Y	N	N	N	16.3	32.6	30	1200	2	20160
6580-2	Y	N	N	N	16.3	32.6	30	1200	2	20160
6580-3	Y	N	N	N	16.3	97.7	30	1200	6	20160
WESTERN DYNEX CORP.										
6000	Y	N	N	N	6.25	6.3	35	312	4	7700
WD505	N	N	N	Y		6.4	35	625	2	10400
ZENITH										
Z67	N	N	Y	N	11	.513	70		6	

FAST.



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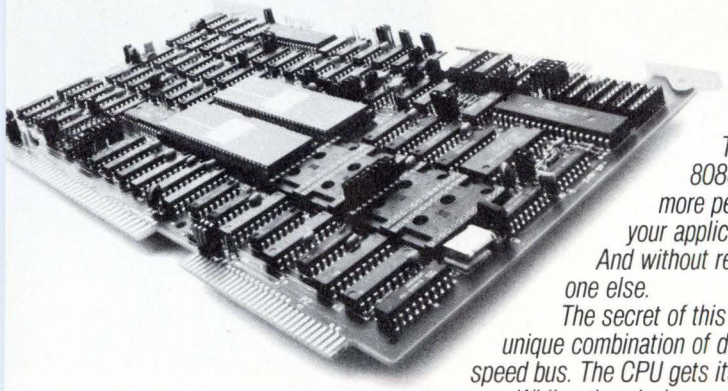
Actuator type	Interface type	Price ($)	Special features
linear voice coil	SMD	17000	
linear voice coil	SMD	18000	
linear voice coil	SMD	19000	
linear voice coil	SMD	17000	
linear voice coil	SMD	18000	
linear voice coil	SMD	19000	
linear voice coil	SMD	17000	
linear voice coil	SMD	17000	
linear voice coil	SMD	19000	
linear motor	various	2100	
stepper motor	ST-506		microprocessor-controlled, thermal compensation
	flat ribbon	5995	read/write protection

FAST AND A HALF.



That's the kind of performance you can expect from Microbar's 8086- or MC68000-based Dual Bus™ Computers. Up to 50% more performance in your Multibus system, depending upon your application. Without sacrificing Multibus compatibility. And without requiring on-board memory that's off-limits to everyone else.*

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So your software can get the most out of this high performance hardware, Dual Bus Computers fully support memory management. Handy for organizing 16 Mbyte address spaces. Absolutely necessary for running advanced operating systems like UNIX and XENIX.**

To help you get the most out of your design efforts, Microbar has developed a Dual Bus Computer design kit. With all the information you need to add a Dual Bus Computer to your system. In a hurry. Because today designing a system fast is not enough. You have to be fast and a half.

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I want to design in fast and a half performance. Fast. Here's $9.95. Rush me the Dual Bus™ Computer design kit, including manuals and technical specs, for the CPU indicated below. Also include the latest copy of the IEEE P796 specifications for the Multibus bus.

_____ 8086 _____ MC68000

Check enclosed _____ MC _____

VISA Card _____ Exp. Date _____

_____ I can't wait for the mail. Have a sales representative contact me.

Name _____

Title _____

Company _____

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CIRCLE NO. 154 ON INQUIRY CARD

It isn't just plug-compatible, it's software-compatible.

Introducing AMS 315, the first Winchester precisely designed to the storage specifications of 300-MB removable pack drives. So for the first time you get all the advantages of a 300-MB Winchester without rewriting your software. Or redesigning your interface.

We're truly SMD compatible.

Century's AMS 315 has the same 20,160 bytes per track.

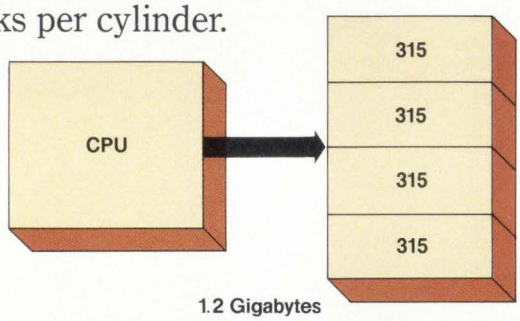
Same 19 tracks per cylinder.

Same 823 cylinders per spindle.

Same 3,600 RPM rotation.

All in one-third the space.

Using less than half the power.



Stack four AMS 315s for 1.2 gigabytes of Winchester storage in about the same space as your 300-MB removable pack drive.

At about two-thirds the initial delivered cost.

Plus you get more than twice the reliability and eliminate preventive maintenance so the on-going cost of ownership is less, too.

Expand your mass storage alternatives with Winchester technology. You'll see the difference right away. Your system never will.

Call to arrange a test drive.

Century Data Systems, Marketing Communications C1-10, 1270 N. Kraemer Blvd., Anaheim, CA 92806, (714) 999-2660.

AMD House, Goldsworth Road, Woking, Surrey, England, GU 21 1JT, 44-4862-27272.

Century Data Systems
A Xerox Company

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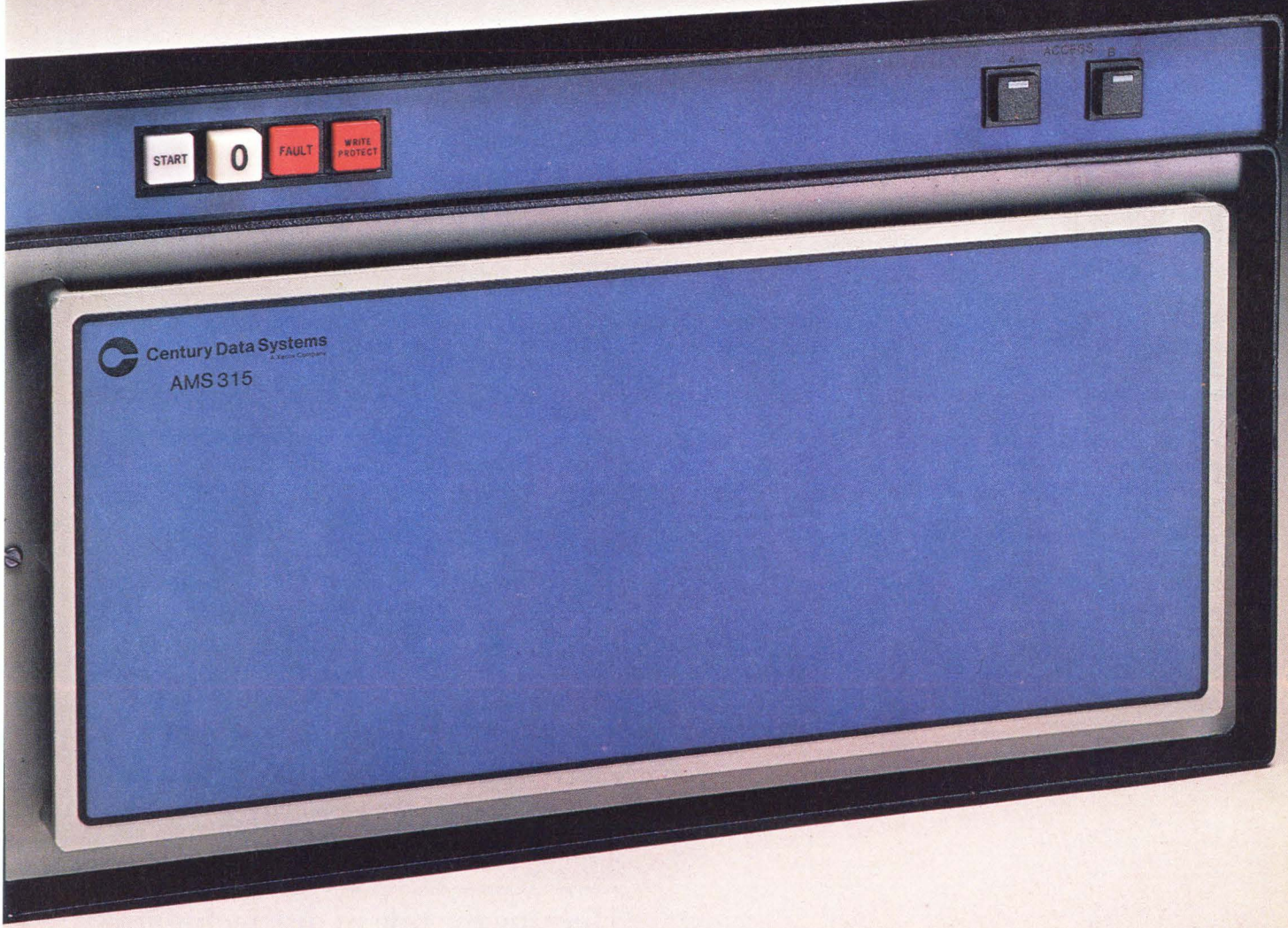
CIRCLE NO. 155 ON INQUIRY CARD

Finally, a Winchester that goes head-to-head, track-to-track, cylinder-to-cylinder, byte-to-byte with 300-MB removable pack drives.



Seagate sets you free.

Free to operate in a portable environment. Free to remove and change the Winchester disc. Free from back-up worries. Free from dependence on floppies. You can have this freedom now. With the Seagate Freedom Generation of 5¼" Winchester cartridge drives.

Our new freedom generation gives your system the performance, capacity and reliability of our standard Winchesters. Plus, for those applications where there's severe shock and vibration, we've added that extra measure of protection provided by plated media.

Free from lack of portability.

The Seagate ST706 more than meets the rugged requirements of portable computers. The removable cartridge virtually eliminates potential disc damage due to severe shock to heads and disc found in portable applications.

Free from back-up worries.

The ST706 is the Winchester that backs itself up. Use it to copy from your favorite Seagate fixed disc drive. Make a 1:1 copy of your ST406 or our new ST206 half-high disc. Do it faster than with tape. And do it with a simple, industry-standard controller.

Free from the limitations of fixed discs.

When you fill up a cartridge, just plug in another. Every cartridge stores a generous five megabytes (formatted).

Free from dependence on floppies.

Now your users can enjoy the portability of removable media, without problems. Seagate's rugged cartridges feature plated Winchester media and are sealed away from contamination.

Set yourself free.

Your system can gain better performance and reliability starting now. So order some ST706 Freedom Generation cartridge drives for evaluation today. Call Seagate.

Seagate Technology

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"Turning the tide in disc technology"

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CIRCLE NO. 156 ON INQUIRY CARD

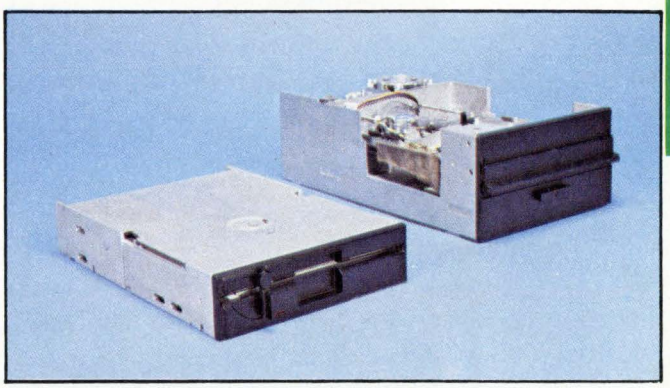
See us at COMDEX Booth #256

Selecting 8-in. floppy disk drives

GEORGE SOLLMAN, Shugart Associates Inc.

A step-by-step evaluation process leads integrators to the best drive for an application

More than 13 years after their introduction, 8-in. floppy disk drives still offer a good combination of price, performance and reliability in both single- and double-sided configurations. They are well-suited for various applications in both stand-alone and distributed systems. New technologies have created exciting new possibilities in terms of overall system performance while increasing the number of alternatives available to prospective customers. A system integrator's job is more challenging than ever, but even today, diskette drive selection can be reduced to a simple, step-by-step process. Considering only those drives with necessary basic performance and reliability features, prospective buyers must determine their major system requirements, investigate which drives will satisfy those requirements and carefully evaluate a vendor.



Half- and full-height 8-in. floppy drives *offer similar capacities, performance and price. System integrators can start with a full-height drive and convert to two half-height drives without major modifications to the system design.*

Get the basics

The first step in drive selection should be selecting a size. In choosing a size, a system integrator determines the drive form factor to be used in a system for years to come. Users of 8-in. floppies, for example, most likely will upgrade to half-height 8-in. floppies or 8-in. Winchesters rather than 5¼-in. products. Staying with the same-sized drive prevents costly and time-consuming system redesigns to accommodate a different-sized drive.

The choice of a standard-height or half-height drive should be made before investigating models or vendors. The recent availability of half-height products has provided an attractive alternative to standard-height drives. These products typically offer the same capacity as standard models in half the space. Thus, as much as 800K bytes of unformatted capacity is available in single-sided models, and as much as 1.6M bytes is available in double-sided models. Because prices of half-heights are roughly comparable to those of their full-sized predecessors, these new products also provide a cost-effective alternative to redesigning a system to accommodate minifloppies, a move involving the sacrifice of substantial investments in media and software.

Besides the benefit of reduced size, many half-heights provide designers with increased performance and higher reliability over previous models. Shugart Associates' SA810/860 series, for example, uses a brushless, direct-drive DC motor not only to achieve reduction to half-height, but also to increase drive reliability through a reduced parts count. Belts and pulleys associated with the AC motor used in earlier models are eliminated in the SA810/860, and the DC motor enhances performance by starting the drive in

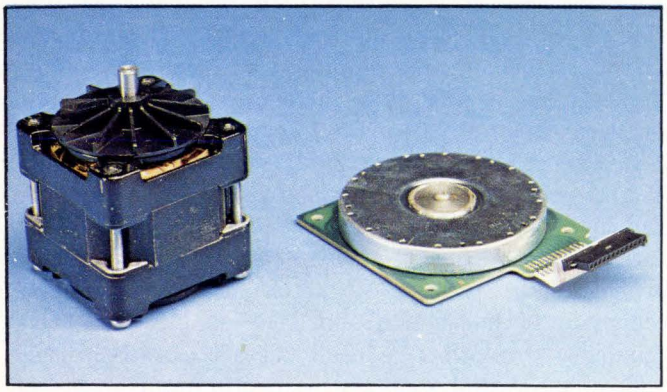
less than one latency (complete rotation of the disk). The head-load solenoid in earlier models is also eliminated, further reducing the parts count and contributing to quiet operation—an important feature for systems used in office environments.

Although half-heights offer many advantages, a case can still be made for selecting full-sized floppies. They are mature products, well-advanced on manufacturing and cost learning curves and are readily available in high volumes. Buyers choosing full-sized floppies are not locked into these products because future upgrades can be made to half-heights or 8-in Winchesters.

When selection begins, only drives with certain performance and reliability features should be considered. The drive electronics should include write-protect circuitry to prevent accidental modification of data, and a door lock prevents removal of a diskette while a drive is operating. Without these features, a user could destroy data while a system was updating a file. Other essential features include an on-board data separator and an index/sector separator if hard-sector media are used.

Typical 8-in. floppy disk drive specifications

Capacity	400K bytes, single-sided, single-density
	800K bytes, single-sided, double-density
	800K bytes, double-sided, single-density
	1600K bytes, double-sided, double-density
Average access time	89 to 210 msec.
Transfer rate	250K bits/sec., single-density
	500K bits/sec., double-density
MTBF	8000 to 10,000 hours
Ambient temperature	50 to,115 °F
Relative humidity	20% to 80%
Component life	5 yrs.
Dimensions	
Full-height drive	4.62 (H) × 9.5 (W) × 14.25 (D) in.
Half-height drive	2.31 (H) × 8.5 (W) × 12 (D) in.



Conventional AC and brushless DC motors *are both used in 8-in. floppy drives. Brushless DC motors use fewer parts and generally provide higher reliability.*

Features and performance

Once fundamental performance and flexibility features have been considered and the choice between full- or half-height has been made, designers should then identify the key drive characteristics required to satisfy the system application. Depending on system use, the most important drive requirement might be capacity, reliability or cost. Because most floppies are used in single-user systems, access time is seldom a major concern, and the 99- to 200-msec. range of current drives is sufficient for most applications.

When selecting floppies for a word-processing system, capacity is probably the most important factor. Even a moderate volume of letters, reports, memos and mailing lists generated in a small to medium department can quickly fill a double-sided diskette. To avoid accumulating an unwieldly number of diskettes, two double-sided, double-density floppies, each providing as much as 1.6M bytes of unformatted capacity, would be a good choice for such a system.

In some applications, reliability rather than capacity is the most important drive requirement. One example is the use of a floppy disk drive to load operating software into a mainframe's main memory. Because banks and insurance companies often use mainframes, a drive breakdown could inconvenience thousands of customers. Capacity is not the dominant factor here, as the operating system typically occupies only a portion of one side of a diskette. In this application, a single-sided drive provides sufficient capacity for the operating system with room for updates and enhancements. Reliability ranks second only to capacity when choosing a drive for word-processing systems because businesses increasingly depend on the ability of these systems to boost office productivity.

Prospective customers seeking high reliability should aggressively question the guidelines used to establish the drive's mean-time-between-failure rating. Duty cycle, for example, could differ for devices with the same MTBF.

Cost, on the other hand, might be the most important criterion to a home-computer user buying a drive as add-on memory. Because many competitive drives are comparable in capacity and performance, saving a few dollars could be the deciding factor for such a low-quantity buyer. When buying in OEM quantities, customers pay about $350 per unit in volumes of 500 for single-sided drives and about $450 for double-sided products. Single quantities sell for about $200 more in each category.

Evaluate the vendors

Careful evaluation of a drive vendor is as important as investigating the drive itself. Today's crowded

INTRODUCING 1.6 Mb REPACKAGED

8″ disk drive

8″ half-height

5¼″ half-height

More Storage. Less Space.

It's new and it's from Mitsubishi: the M4854 half-height 5¼″ flexible drive. The M4854 delivers up to 1.6 Mb of storage – the same as most 8″ drives – yet it takes up only half as much space as a conventional 5¼″ drive. Not bad, considering the M4854 is about the same price as most conventional 5¼″ disk drives. And just in case you prefer a half-height unit with 1.0 Mb of storage, Mitsubishi also makes the M4853.

More Features. Less Money.

As with all other Mitsubishi flexible disk drives, the M4854, 1.6 Mb, 5¼″ half-height offers more than a lot of memory. It gives you many features:

Like a head load mechanism with all ferrite heads. A patented circular Gimbal support that ensures stable read/write operation and long media life. An advanced Direct Drive brushless DC Motor that eliminates all concern for changing drive belts. It also provides the torque necessary to reduce the disk rotation starting time to only 250 milliseconds. And for speed, the M4854 has a steel band head positioning mechanism which results in a track-to-track time of only three milliseconds and average access time of 91 milliseconds.

You'll also find Mitsubishi OEM prices are extremely competitive.

More Products. Less Hassle.

Of course, features like these aren't just limited to Mitsubishi 5¼″ half-height drives. You'll find them throughout the entire Mitsubishi line, which includes standard-height 5¼″ fixed and flexible drives, 8″ fixed drives and 8″ full and half-height flexible drives.

More Reliability. Less Maintenance.

Now that you know what goes into our drives, you'll know why they have a MTBF rate of 10,000 POH or more. Unit life is even more impressive – 5 years or 20,000 power-on hours, whichever occurs first. No matter which type of drive you need, Mitsubishi has a package that's just right for you. For details on the entire line, contact your Mitsubishi representative today.

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CIRCLE NO. 157 ON INQUIRY CARD

market demands that qualified vendors provide support before, during and after a sale. System integrators should remember that diskette drives represent an increasing percentage of system cost—as much as 60 percent in the case of many microcomputers—so the drives have a great impact on the integrator's business reputation and bottom line. As is the case with selecting the drive itself, a few basic questions simplify the process of determining whether a vendor is the right one.

Vendor evaluation checklist

Category

- High-volume production
- Commitment to new manufacturing processes
- Quality assurance program
- Post-sale support
- Inexpensive product integration
- Regional repair centers
- Product documentation
- Complete product line
- Vendor's financial resources
- Product introduction track record
- Corporate R&D commitment
- Customer references

First, does the vendor have an established track record for high-volume disk drive production? Also, what level of testing and quality assurance is in place at the factory? Is complete documentation and post-sale technical and application support available? Is the vendor committed to producing compatible follow-on products to help satisfy tomorrow's market requirements?

A visit to the vendor's factory is probably the most reliable means of answering many of these questions. This allows prospective customers to see the vendor's general level of operation as well as its commitment to quality assurance, technical support and account management.

High-volume production and manufacturing innovation are essential to lowering the cost of drives sold to OEMs. When visiting a diskette factory, prospective customers should ask about new manufacturing processes being implemented or considered. Shugart, for example, is using robotic technology and progressive assembly to increase production volume and to maintain high quality and low cost.

Quality and reliability are especially critical with the large number of vendors in the market. This intense competition means that quality levels acceptable today will be rejected by customers tomorrow as more reliable products become available from other vendors. When evaluating vendors, prospective customers should look for a quality-assurance program to prevent problems before drives are shipped instead of when they are in the field. Such a program considers product reliability while a drive is on the drawing board, uses high-quality parts obtained through stringent vendor qualification, monitors drive assembly and maintains effective channels for customer feedback to identify and correct recurring problems.

Strong post-sale support is another essential service provided by qualified disk drive vendors. Post-sale support should include easy access to application engineers to help quickly integrate drives into new or existing systems, and to technical support people to answer questions about drive functions and performance. Comprehensive documentation is a sign of a good customer support organization.

Quality levels acceptable today will be rejected by customers tomorrow as more reliable products become available from other vendors.

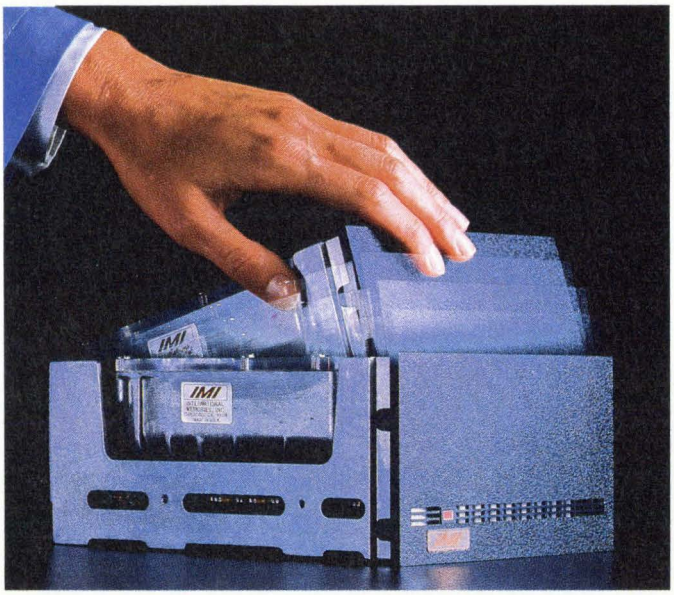
Other major post-sale considerations are the number and locations of a vendor's regional service centers. Are repair centers readily available, or must drives be returned to the factory for repair? Also, do the repair centers include facilities for repairing Winchester disk drives? This could be important when a system integrator or his customers want to upgrade from floppies to Winchesters.

The vendor's product line and its track record are its résumé. A buyer should check whether a vendor is a one-product company or a full-line supplier. A company that offers a complete product line has greater experience and depth of personnel to satisfy current and future needs for rotating memory devices. The transition to higher performance, higher capacity drives can be simplified if an upgraded product is available from the current supplier. Qualifying a new vendor and interfacing new drives is expensive. A buyer should make sure the vendor has a proven track record of introducing higher performance, higher capacity follow-on products.

As a final step in vendor selection, the vendor's R&D efforts should be considered. What methods, products and technologies are receiving attention? The answers to these questions reveal a vendor's commitment to serving the customer's needs tomorrow as well as today. □

George Sollman is vice president and general manager of marketing at Shugart Associates, Sunnyvale, Calif.

IMI reinvents the 5¼" Winchester. And backs it with a 2-year warranty.



NOW FASTER · 68 MSEC (INCLUDES SETTLING TIME) · ACCESS TIME

If our new 5000H Series drives weren't the most reliable 5¼" Winchesters ever built, we wouldn't give them an unprecedented 2-year warranty.

Don't expect to use it, though.

5000H Series drives are made to withstand the everyday abuse known as "normal system usage." And to give continuously superior performance in even the most demanding applications.

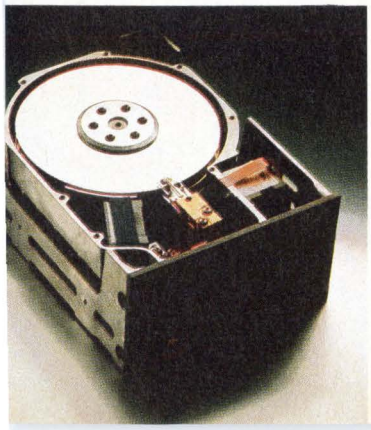
So the overwhelming odds are that the 2-year warranty will expire long before the drive ever does.

THIN-FILM PLATED MEDIA PRESERVES DATA INTEGRITY, INCREASES STORAGE CAPACITY.

To ensure that 5000H drives withstand harsh treatment without sacrificing data integrity, the media is thin-film plated. Thin-film plating is orders of magnitude more shock resistant than ferric oxide coatings and many times harder. Because it's not easily damaged, data is not easily lost, and the drive remains in service.

Thin-film plated media also allows greater bit densities, as much as 10,700 bpi. This has enabled IMI to up the unformatted storage capacity of the 5021H drive, for example, to 21 Mbytes.

And to improve data integrity even further, we've maintained industry standard formats and transfer rates with lower track densities.



NEW 2-PIECE SHOCK-MOUNTED CHASSIS EXTENDS SERVICE LIFE.

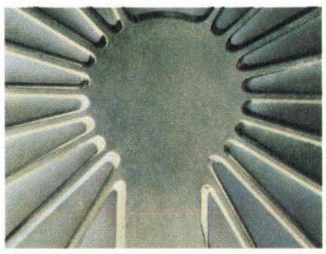
To protect the heads and disks, we've recessed the head/disk assembly inside a rigid, die-cast frame enclosure. Integral shock mounts at the center of gravity insulate the head media interface from the environment.

Besides reducing acoustical noise, this 2-piece design minimizes vibration and shock loads transferred to the heads and disks during installation and use. Even the printed circuit boards utilize the shock-mounted design to lessen stress on the components.

NEW THERMALLY STABLE DESIGN ENSURES OPTIMAL HEAD POSITIONING.

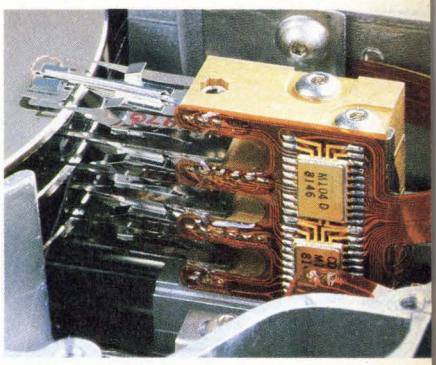
5000H Series drives have a deeply finned die-cast base and cover that increase both the stiffness of the structure and the surface area for heat transfer.

When thermal distortion of the head/disk assembly is minimized, head positioning is optimized. And the combination of temperature stability and lower track densities substantially reduces the potential for off-track errors.



HEAD-MOUNTED PREAMPLIFIER PROVIDES MAXIMUM NOISE IMMUNITY.

Only IMI puts the read/write preamplifier on the head stack, where it greatly reduces EMI/RFI noise susceptibility. This, coupled with the inherently higher signals of plated media (>50%) and the shielding of the all metal frame, yields the best signal to noise ratio in the industry.



A FULL LINE OF HIGH PERFORMANCE 5¼" WINCHESTERS.

Although the unformatted storage capacity ranges from 6.38 Mbytes to 21 Mbytes, depending upon the drive model and interface, all 5000H Series drives feature:

- 68 msec access time.
- 303 tpi.
- 3600 rpm.

For specification sheets, call or write: International Memories Incorporated, 10381 Bandley Drive, Cupertino, CA 95014. (408) 446-9779. TWX: 910-338-7347

IMI

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Nov. 29-Dec. 2, 1982
Las Vegas Convention Center
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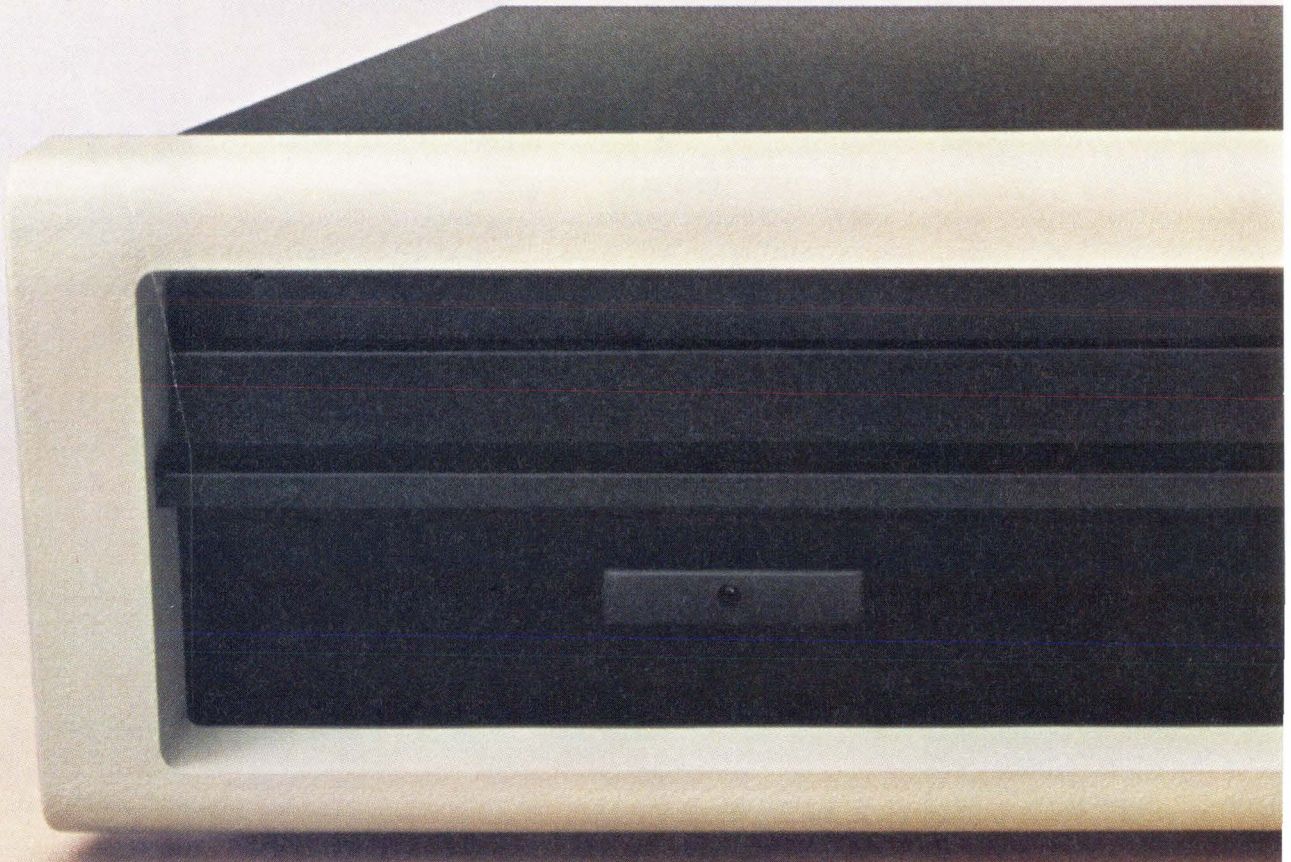
CIRCLE NO. 158 ON INQUIRY CARD

THE DSD 880 WINCHESTER SYSTEM.

MADE THE WAY DIGITAL WOULD MAKE IT.

EXCEPT DIGITAL DOESN'T MAKE IT.



See us at Booth 3022
COMPEX
Nov. 29-Dec. 2, 1982

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PDP is a registered trademark of Digital Equipment Corp.

The people at Digital are a pretty smart bunch. They make some of the finest small computers in the world. So we like to think that if they were to make a new storage system like our 880 Winchester/Floppy, they'd do it the same way we did.

First of all, they'd make it extremely reliable with extensive testing and by using one of the most reliable storage technologies known, the Winchester.

Next, they'd offer it in different capacities, like 7.8, 20.8, and 31.2 megabytes, with a choice of .5 or 1 Mb floppy back-up, or none at all.

These different configurations would, of course, be fully compatible with Digital's LSI-11 and PDP®-11 computers.

And the whole package would be extremely compact, just 5¼ inches high, so it would save space and fit in almost anywhere.

They might even add some on-board self-diagnostics, similar to our exclusive HyperDiagnostics,™ so you could test, exercise, and debug without a CPU. And cut down on your service costs at the same time.

Maybe they'd even institute a module swap program, something like our Rapid Module Exchange,™ which would be designed to get you back up and running within twenty-four hours.

Finally, since this system would be so dependable, they'd be able to offer their extended service at a much lower price—much like we do with our own HyperService,™ which goes into effect when the 90-day warranty expires and covers everything.

And then, as if it weren't good enough already, they'd offer this remarkable storage system at a lower cost per megabyte than any comparable system.

The fact is, though, Digital doesn't make anything like this.

Which is why we make the DSD 880 Winchester system to go with your Digital computer.

And, why we make it the way we do.

Corporate Headquarters: 2241 Lundy Avenue, San Jose, CA 95131. Eastern Region Sales and Service: Norwood, MA, 617 769-7620. Central Region Sales: Dallas, TX, 214 980-4884. Western Region Sales: Santa Clara, CA, 408 727-3163.

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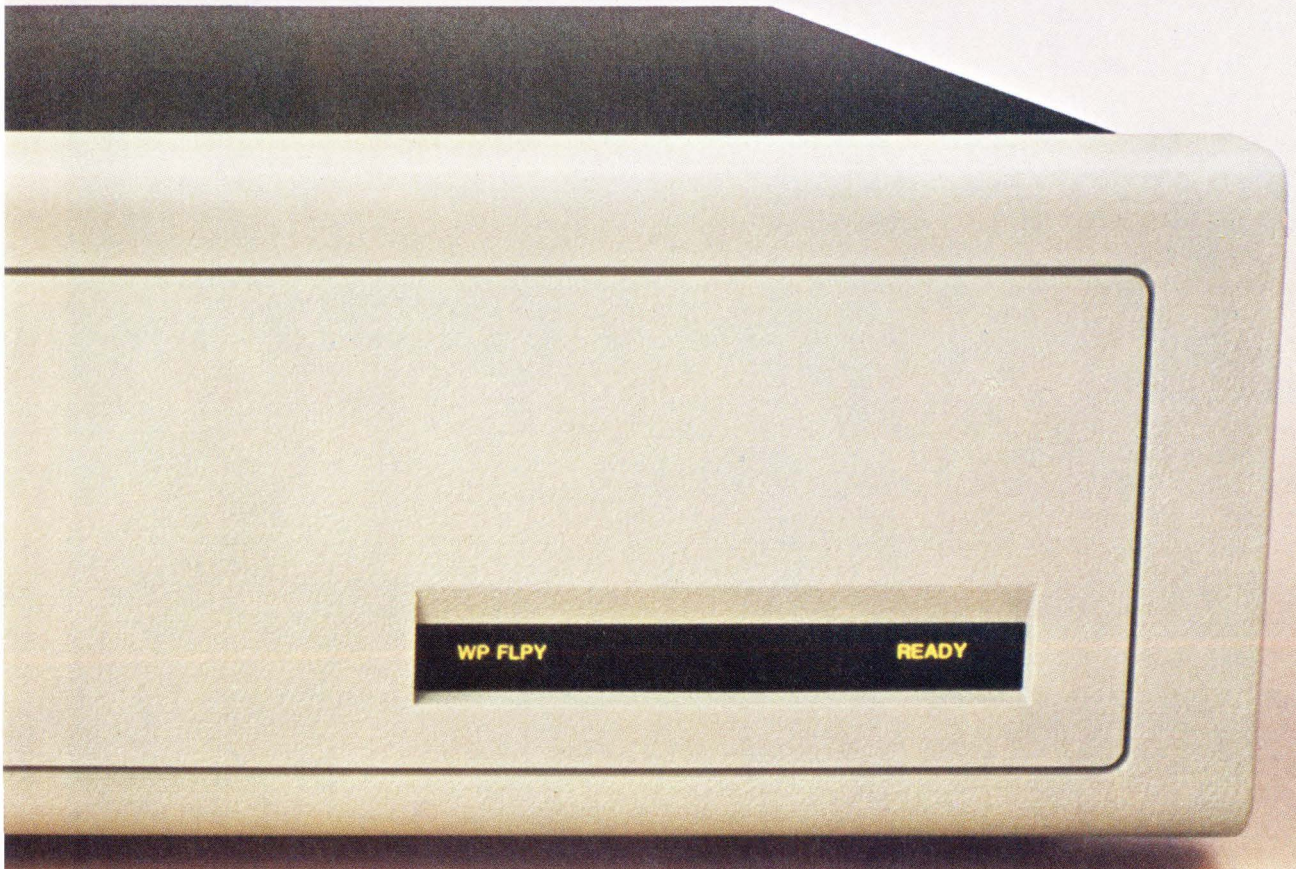

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CIRCLE NO. 159 ON INQUIRY CARD

8-IN. DISKETTE DRIVES

Company Model	Single-sided (Y/N)	Double-sided (Y/N)	Capacity (K bytes)	Avg. access time (msec.)	Transfer rate (K bytes/sec.)	Tracks/ surface	Tracks/ in.	Price ($)	Dimensions (H x W x D, in.)
ADVANCED ELECTRONIC DESIGN, INC.									
Flex02	Y	Y	1000	91	67	77	48	4080	5.3 x 16.8 x 22
BASF									
6104	N	Y	1600	76	500	77	48		4.3 x 8.7 x 14.1
6105	N	Y	1600	76	500	77	48		2.2 x 8.5 x 13.0
BILLINGS CORP.-CALDISK DIVISION									
142M	Y	N	800	239	500	77	48		4.9 x 8.4 x 15
143M	Y	Y	1600	239	500	77	48		4.9 x 8.4 x 15
143M1	Y	N	800	239	500	77	48		4.9 x 8.4 x 15
842D	Y	Y	1600	239	500	77	48		4.9 x 8.4 x 15
848	Y	Y	1600	239	500	77	48		4.9 x 8.4 x 15
896	Y	Y	3200	239	500	154	96		4.9 x 8.4 x 15
BURROUGHS CORP.									
MD-122	N	Y	3131	40	0	139	150		5.5 x 10.0 x 20.5
COMARK CORP.									
MF 80	Y	N	3200	260	250	77	0	995	
QF-11	Y	Y	512			77	0	3450	5.2 x 17.4 x 22.6
CONTROL DATA									
9404	Y	N	400/800	260	250/500	77	48	425, Q2500	5.0 x 8.8 x 14.0
9404-B	Y	N	400/800	275	250/500	77	48	330, Q2500	5.0 x 8.8 x 14.0
9406-1	N	Y	800/1600	40	250/500	77	48	530, Q2500	5.0 x 8.8 x 14.2
9406-4	N	Y	800/1600	91	250/500	77	48	485, Q2500	4.7 x 8.6 x 14.0
ELCOMATIC LTD.									
ACP1500 (DC)	N	Y	3200	101	500	144	96	650, Q100	4.4 x 8.5 x 12
ACP700 (AC)	N	Y	1600	101	500	77	48	500, Q100	4.4 x 8.5 x 12
ACP750 (DC)	N	Y	1600	101	500	77	48	500, Q100	4.4 x 8.5 x 12
INNOTRONICS CORP.									
410	Y	Y	802		0	77	48		4.4 x 9.0 x 14.0
420	Y	Y	802		0	77	48		4.4 x 9.0 x 14.0
IOMEGA CORP.									
Alpha-10	Y	N	14000	55	113	306	300	2390	4.5 x 8.5 x 14.3
IRWIN/OLIVETTI, INC.									
FD502	Y	Y	500	333	250	40	48	235, Q500	3.3 x 5.8 x 8.0
MATCHLESS SYSTEMS									
SL-848-1	Y	N	1300		500	77	48		2.5 x 8.5 x 14.0
SL-848-2	N	Y	2600		500	77	48		2.5 x 8.5 x 14.0

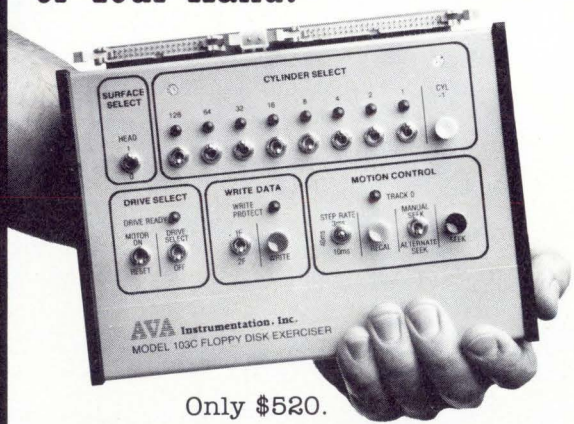
8-IN. DISKETTE DRIVES

Company Model	Single-sided (Y/N)	Double-sided (Y/N)	Capacity (K bytes)	Avg. access time (msec.)	Transfer rate (K bytes/sec.)	Tracks/ surface	Tracks/ in.	Price ($)	Dimensions (H x W x D, in.)
MEMOREX CORP.									
550	Y	Y	802	10	0	77	48		4.4 x 8.8 x 14.0
651	Y	N	312	10	0	64	48		4.5 x 9.0 x 14.0
MICRO PERIPHERALS, INC.									
42	N	N	1600		500	154	48	500, Q500	3.3 x 5.8 x 7.5
MILTOPE CORP.									
DD400	Y	Y	1000	6	500	77	48	4975	6 x 10 x 18
MITSUBISHI ELECTRONICS AMERICA, INC.									
M2894-63	Y	Y	1600	91	63	77	48	390, Q1000	4.6 x 8.5 x 14.1
M2896-63	Y	Y	1600	91	63	77	48	380, Q1000	2.2 x 8.5 x 12.4
MOTOROLA, INC.									
Exordisk II	Y	N	500	177	250	78	48	4495	18.5 x 26.0 x 7.0
Exordisk III	N	Y	1000	177	250	78	48	4195	18.5 x 26.0 x 7.0
NEC INFORMATION SYSTEMS, INC.									
FD1164	Y	N	400	0	31	77	48		2.3 x 8.5 x 13.2
FD1165	Y	Y	1600	0	63	77	48	395, Q500	2.3 x 8.5 x 13.2
PERSCI, INC.									
277	Y	Y	802		0	77	48		4.4 x 8.6 x 15.0
299B	Y	Y	1600		0	77	48		4.4 x 8.7 x 15.4
699	Y	Y	3200		0	154	96		4.4 x 8.7 x 15.4
899	Y	Y	3776		0	231	150		4.4 x 8.7 x 15.4
PERTEC COMPUTER CORP.									
FD 410	Y	Y	802		0	77	48		3.5 x 8.6 x 14.9
FD 500 Series	Y	Y	802		0	77	48		3.5 x 8.6 x 14.9
FD 650	Y	Y	1600		0	77	48		4.5 x 8.6 x 14.0
QUME CORP.									
Qumetrack 842 DC	Y	Y	1600		0	77	48		4.6 x 8.6 x 14.6
REMEX									
RFD 2000	Y	N	800	91	500	77	48		4.6 x 8.6 x 14.0
RFD 2001	N	Y	800		0	77	48		4.6 x 8.6 x 14.0
RFD 4000	Y	N	1600	91	500	77	48	365, Q2500	4.6 x 8.6 x 14.0
RFD 4001	N	Y	1600		0	77	48		4.6 x 8.6 x 14.0
SHUGART ASSOCIATES									
SA801	Y	N	800	210	500	77	48	390, Q200	4.6 x 9.5 x 14
SA810	Y	N	800	89	500	77	48	385, Q200	2.3 x 8.6 x 12
SA851	N	Y	1600	91	500	77	48	495, Q200	4.6 x 9.5 x 14
SA860	N	Y	1600	89	500	77	48	465, Q200	2.3 x 8.6 x 12

8-IN. DISKETTE DRIVES

Company Model	Single-sided (Y/N)	Double-sided (Y/N)	Capacity (K bytes)	Avg. access time (msec.)	Transfer rate (K bytes/sec.)	Tracks/ surface	Tracks/ in.	Price ($)	Dimensions (H x W x D, in.)
SIEMENS CORP.									
FDD 100-8	Y	Y	800		500	77	48	590	4.5 x 8.6 x 14.3
FDD 200-8	Y	Y	1600		500	77	48	720	4.5 x 8.6 x 14.3
TANDON CORP.									
TM 848-2	N	Y	1600		500	77	48	405, Q500	2.3 x 8.5 x 13.1
TM848-1	Y	N	800		500	77	48	350, Q500	2.3 x 8.5 x 13.1
TOSHIBA CORP.									
ND-108	Y	N	400		0	77	48		4.9 x 10.0 x 14.4
ND-20D, ND-20DL	Y	Y	1600		0	77	48		4.9 x 10.0 x 14.4
Y-E DATA, INC.									
YD-174D	N	Y	1600	91	500	77	48		4.5 x 8.6 x 14.6
YD-180	N	Y	1600	91	500	77	48		2.3 x 8.6 x 12.6

Winchester/Floppy Drive Exercisers That Fit the Palm of Your Hand.



Only $520.

Now test both 5¼″ and 8″ Floppies, and many 5¼″ and 8″ Winchesters with one lightweight, portable exerciser. Recommended by Shugart, Tandon, and other leading manufacturers, the Model 103C is ideal for incoming inspection, repair depot, and field service use.

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1. Names and complete addresses of the Publisher, Editor, and Managing Editor are: Vice President and Publisher, S. Henry Sacks, 221 Columbus Ave., Boston, MA 02116. Editor-in-chief, Lawrence J. Curran, 221 Columbus Ave., Boston, MA 02116. Managing Editor, Peter P. Hayhow, 221 Columbus Ave., Boston, MA 02116.
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	Average No. Copies Each Issue During Preceding 12 Months	Actual No. Copies of Single Issue Published Nearest to Filing Date
A. Total No. Copies Printed (Net Press Run)	110,903	116,499
B. Paid Circulation		
1. Sales through dealers & carriers, street vendors and counter sales	None	None
2. Mail Subscriptions	2,105	2,230
C. Total Paid Circulation	2,105	2,230
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We've taken a hard look at disc technology, and decided to be flexible.

Brown Disc introduces hard disc capability with the convenience and low cost of a floppy.

Only Brown Disc offers processing technologies normally associated with hard disc manufacturing: An exclusive spin coating technique produces a thinner coating with high bit integrity for ultra-hi densities. A special overcoat and primer layer are used to increase adhesion, disc life and head life. Plus individual stress relieving improves substrate stability.

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For the OEM, we can provide a truly high quality state-of-the-art floppy to market under your label. For Software Houses, you can put your program on a floppy that's reliable. And for Distributors and Retailers, you can show serious mini and micro-computer users that you stock the media they'll be asking for.

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VHR-I-II	120 μ in.	300 oersted	6,200 BPI	1.0 megabyte
UHR-I	60 μ in.	300 oersted	10,000 BPI	3.2 megabyte
UHR-II	45 μ in.	600 oersted	10,000-18,000 BPI	5.0 megabyte

brown disc

We're driving the drive market.

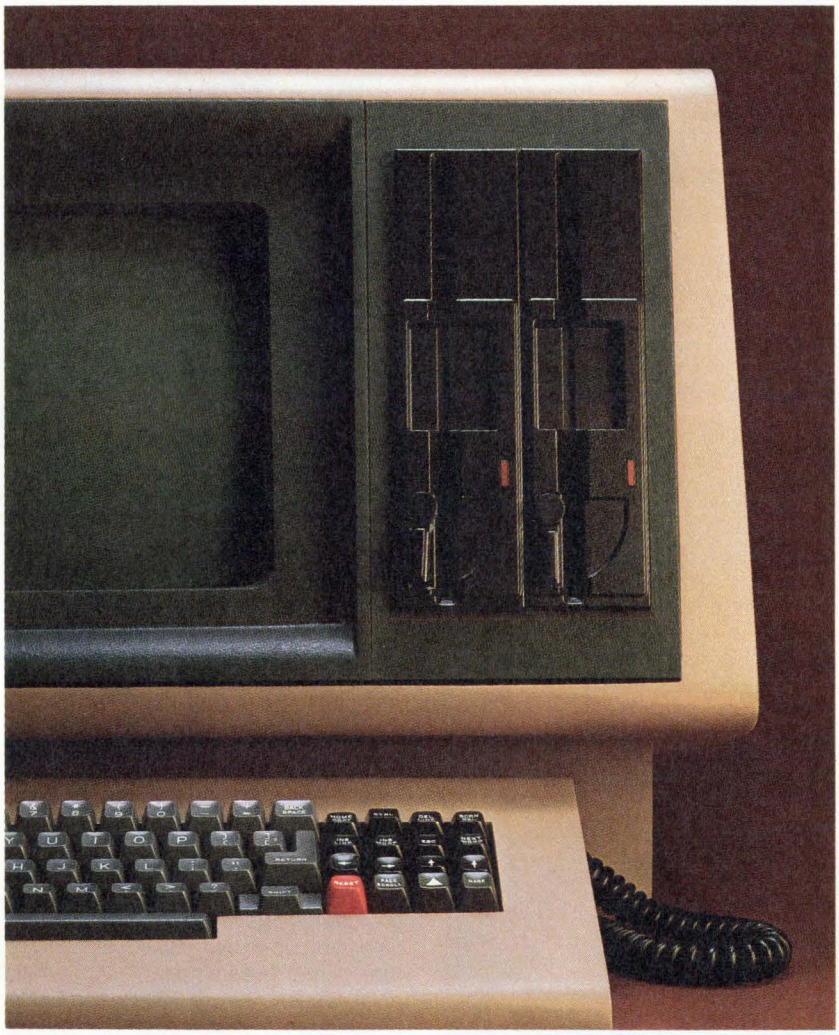
CIRCLE NO. 161 ON INQUIRY CARD

OUR NEW 8" DRIVES PUT US IN A TIGHT SPOT.

They're half the height of a conventional 8-inch floppy.

The exact depth of a standard 12-inch CRT terminal.

And actually capable of squeezing 8-inch drive performance into desktop systems that haven't room for full size 8-inch drives.



What's more, they're Shugart's newest family members—our SA810 single-sided and SA860 double-sided floppy disk drives.

These half-height 8-inch drives offer the OEM more design flexibility, while providing an attractive new alternative to today's minifloppies.

Unlike other reduced height drives, only Shugart's SA810/860 series eliminates the need for major redesigning of hardware. And software. And controllers.

Because they're compatible with our industry standard SA801/851 8-inch drives. Same mounting holes. Same internationally recognized DC power supply. Same controller interface. And all the jumper options you need to build in the features you need.

They're also compatible with the existing user base of over 200 million 8-inch diskettes.

And the SA810 and SA860 offer distinct advantages over 5¼-inch drives, including more capacity. In the case of the SA860 (1600 kilobytes), 60 percent more than a double-sided 96-TPI minifloppy. With faster access times (89 msec versus 158 msec average). And faster transfer rates (500 versus 250 kilobits per sec).

They also offer a bundle of features not found in conventional 8-inch drives.

The rapid start DC motor, for example, eliminates the need for belts, pulleys, and head-load solenoids. So reliability is substantially increased. Media wear is reduced. And overall operation is much quieter.

All of which makes our new SA810/860 drives the smart solution for a wide range of high performance desktop applications—from word processing to distributed network systems.

All backed by the industry's largest and most experienced engineering, sales and service organizations.

For more details, contact Shugart Associates, 475 Oakmead Parkway, Sunnyvale, CA 94086, (408) 733-0100 (Hamilton/Avnet, authorized distributor).

And see if you can squeeze us in.

Shugart

Right from the start.

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CIRCLE NO. 162 ON INQUIRY CARD

Storage Cells from Xylogics

More Data Storage for Your Money

Xylogics Storage Cells: A totally new way to solve data storage problems on VAX*, PDP-11*, LSI-11, Nova/Eclipse** and Multibus*** compatible systems. We start with the proven performance, reliability and economy of our Peripheral Processors for 100% software compatible control. Then we add state-of-the-art peripherals like high-performance fixed disk and removable cartridge Winchesters, ¼″ cartridge tapes, and reel-to-reel tapes for start-stop or streaming operation. And we wrap everything up in a series of modular cabinets that integrate perfectly with your computer packaging.

Storage Cells: They give you more choices, more capacity and more convenience in less space, and at lower cost than any other data storage subsystem on the market.

More Solutions for Your System

Now you can forget about data storage limitations. With Storage Cells you can get the perfect combination of capacity and application-oriented features in an incredibly compact package. Consider the XSC100 for VAX and PDP-11 systems. In a single bay cabinet only 40″ high, this Storage Cell gives you up to two 160MB disks plus a reel-to-reel streaming tape with emulation of DEC's RK07's or RM02's and TS04 peripherals.

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CIRCLE NO. 163 ON INQUIRY CARD

Selecting a 5¼-in. diskette drive

Bill Williams, Tandon Corp.

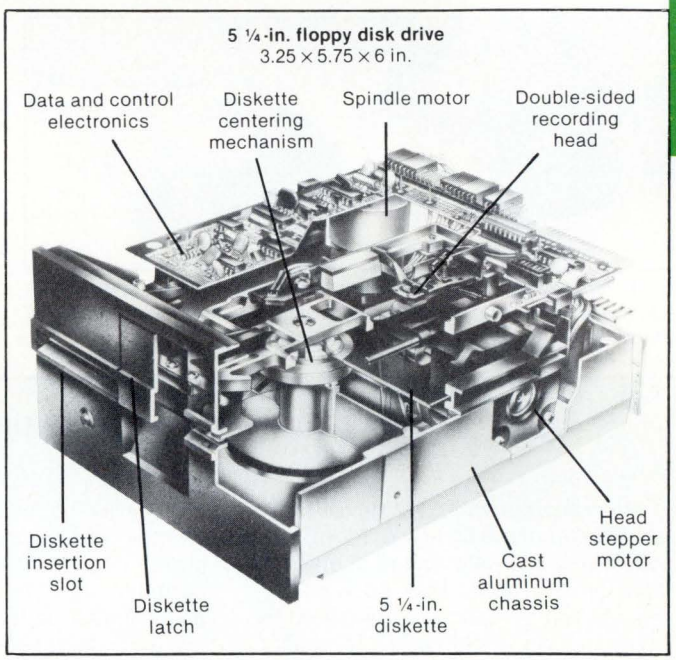
OEM mini-diskette drives are more versatile than ever, but choosing one involves some trade-offs

Diskette drives originated in the early 1970s with 8-in. media and were used primarily for loading programs into computer systems. The 5¼-in. diskettes popular now are used as mass-storage devices in small computer systems, data-collection terminals and programmable instrumentation. A large number of disk drives with a wide range of features and performance characteristics is available. To select a 5¼-in. diskette drive, a system integrator must evaluate nearly a dozen parameters, weighing trade-offs and benefits. Among key selection criteria are price, capacity, access time, operational features, reliability and the ability to be upgraded.

Price is the main issue

System designers and integrators evaluating 5¼-in. diskette drives face an embarrassment of riches. Large-scale price reductions in the past year are making this product a virtual commodity, with prices on some popular models cut 50 percent or more. Manufacturers are also offering increased performance: the 1M-byte drive is becoming commonplace, and 2M-byte drives are available. Even while seeking a bargain, a system designer should select a vendor that can meet his delivery, service and quality requirements. Regardless of the pricing level, the price that is ultimately paid also depends on the quantity and performance of the 5¼-in. drive.

Pricing is based on a stairstep structure, with successively higher discounts for quantity purchases. This structure provides a logical, negotiable basis for OEM purchases from one to 10,000 units a month and beyond. The quantity needed can also dictate the vendor selected. A high-volume requirement, such as 10,000 per month, may be satisfied only by a manufacturer that can produce quickly and efficiently to a customer's schedule.



Cutaway of Tandon 5¼-in. diskette drive *shows the main elements of the drive.*

A lowest price, basic, mechanics-only drive becomes more expensive as capabilities are added: The manufacturer can provide electronics, or the customer can save money by using his own. He can start from the 250K-byte capacity of a 48-tpi single-sided drive, and expand to 2M bytes with a 96-tpi, double-sided drive. Price will also be affected by features and options that add sophistication and security to a drive.

Delivery arrangements should also be considered. Evaluation units of most 5¼-in. diskette drives are generally available immediately from most manufacturers. Small quantities often can be delivered within 30 days. Larger quantity deliveries are negotiable, and depend on a vendor's production capacity and commitments.

Standardization minimizes compatibility problems

Standardization of 5¼-in. diskette drives has been achieved in physical envelope, interface, power level and connector areas. Thus, a system designer is virtually assured of a second source and has the flexibility of changing manufacturers.

The 5¼-in. envelope has been standardized at a configuration of 3⅜ × 5¾ × 8 in. A drive can be mounted in any orientation—upright, horizontal or vertical. The need for more capacity in a standard 5¼-in.-wide envelope has prompted a trend to half-height configurations (Fig. 1). This configuration is 1⅝ in. high—one-half of a standard drive—with all other dimensions remaining the same. Thus, a designer can stack two drives in one envelope. Half-height models are available with performance characteristics that range to that of a full-sized drive. Cost is often significantly lower for the half-height products. These slimmed-down units find major applications in under-the-keyboard systems, often stacked side by side.

An industry-compatible interface standardizes the communications between the controller and disk drive through a 34-pin edge connector (Fig. 2). Because the

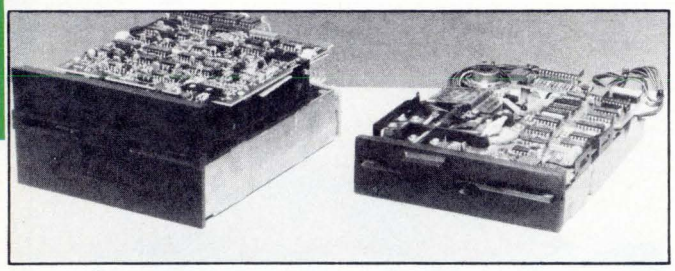


Fig. 1. Standard- and half-height diskette drives *have similar performance features, but two half-height units can fit in the space of a standard unit and give twice the capacity.*

Input Control Lines (Controller-To-Disk-Drive)		
Ground	**Pin**	**Signal**
1	2	Connector Clamp
3	4	Spare
5	6	Drive Select 3
9	10	Drive Select 0
11	12	Drive Select 1
13	14	Drive Select 2
15	16	Motor On
17	18	Direction Select
19	20	Step
21	22	Composite Write Data
23	24	Write Enable
31	32	Side One Select
Output Status Lines (Disk Drive-To-Controller)		
Ground	**Pin**	**Signal**
7	8	Index/Sector
25	26	Track 0
27	28	Write Protected
29	30	Composite Read Data
33	34	Connector Clamp

Fig. 2. Industry-standard interface *for 5¼-in. diskette drives is based on a 34-pin connector. Control and status-line design reflects an open-loop configuration.*

HOW DO SPECS HOLD IN DIFFERENT ENVIRONMENTS?

As computers and disk drives leave the shelter of the computer room, they encounter a greater range of environmental conditions. Disk drive performance can be seriously hampered by extremes of temperature, humidity, shock, vibration and electrical noise. In selecting a disk drive, a familiarity with how specifications will be affected by the environmental situation is essential.

Disk drives are designed to operate within the temperature range that the media can withstand, with the upper limit set at 44°C (112°F). Some drive manufacturers, however, have expanded this to 46°C in their specifications. This increased range presents no problems to the basic components, such as ICs, aluminum mountings, stepper motors and PC boards. But the media do not fare as well. As temperature increases, the media jacket begins to deform, sometimes permanently. Mylar media expand and contract as temperature increases and decreases, and a circular diskette can distort into an elliptical shape at higher temperatures. This distortion can cause major read/write errors through off-track operation.

Hygroscopic effects caused by humidity extremes are also more pronounced in the media than in the drives. Drive manufacturers recommend an operating range of 20 to 80 percent relative humidity, but even in this range, expansion and contraction of the media can cause read/write errors.

All diskette drives manufactured perform within specified shock and vibration parameters. Most endure the typical bumps of office life, but a drive that is dropped or subject to movement during read/write operations is likely to generate errors.

A disk drive is considered a computer component and, as such, is exempt from American FCC and European VDE standards for radio-frequency interference and electromagnetic interference. However, some manufacturers make drives that pass these tests. VDE is not the only safety agency in Europe that performs RFI/EMI tests. Many countries have their own safety agencies, and drives must be submitted to the agency in each country in which drives are used.

Do other diskette makers have this secret ingredient

$$V(Y|X) = V\left(\sum_{j=1}^{K}\beta_j X_j + \epsilon\right) = V\left(\sum_{j=1}^{K}\beta_j X_j\right) + \sigma^2$$

$$= \sum_{j=1}^{K} X_j^2 V''(\beta_j) + \sum_{\substack{i=1 \\ i\neq j}}^{K}\sum_{j=1}^{K} X_i X_j \mathrm{cov}''(\beta_i, \beta_j) + \sigma^2$$

that we don't have?

And, can it cause the floppy diskette you're using right now to flop ... with the loss of your precious data and endless trouble? You just bet it can!

The formula above represents Variance, which is the primary enemy of quality control. At the Nashua diskette plant, production workers in clean gowns and gloves wage a holy war on variance, using statistical control (with literally hundreds of charts and records updated constantly) as an integral part of the manufacturing process to achieve absolutely consistent quality.

No one else in the magnetic media world operates exactly this way. That's why, with Nashua, your valuable data is safe and secure. With other makers, it may be.

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The sharks are gathering 'round. The diskette market is exploding in size and everyone is out to grab his share, plus more. Meanwhile a lot of people are forgetting that this very precise, highly engineered product has plenty of potential for disaster for the user if things aren't right.

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CIRCLE NO. 164 ON INQUIRY CARD

5¼-in. diskette drive is an open-loop system, most of the communications involve commands from the controller to the disk. The controller signals the selection of the drive, motor start-up, spindle direction, head movement, data to be recorded, write enabling and disk side selection through pre-determined pin assignments. Drive-to-controller signals move through the remaining pins. They communicate index/sector location, position of the first track, data retrieved and write-protection status.

An average 5¼-in. diskette drive weighs less than 3½ lbs., but weights vary widely among manufacturers. While not a critical factor in most desk-top applications, weight becomes more important when drives are shipped long distances, particularly overseas. Voltage levels are standardized at +12V and +5V DC.

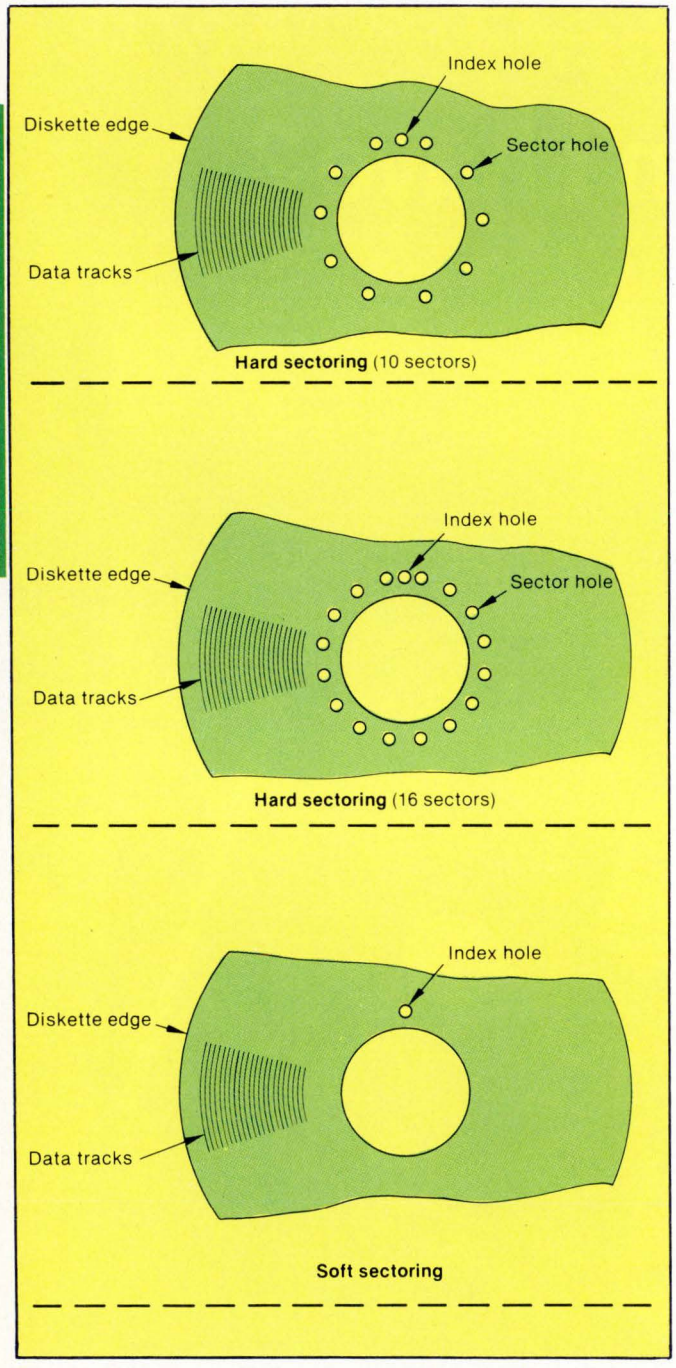

Fig. 3. Hard- and soft-sectoring techniques *differ in that hard sectoring uses punched holes to locate sectors, while soft sectoring uses a timing pulse under software control. Hard sectoring uses 10- or 16-sector formats, while soft-sector formats can vary, although 16 is most common. Both techniques use an index hole to initiate sector location.*

Capacity selection

Capacity is a function of a disk sectoring and recording technique. A system designer beginning with a drive having a specified unformatted capacity determines the formatted capacity by organizing the media surface into sectors. Sectoring is classified as soft or hard (Fig. 3).

The basic, mechanics-only drive becomes more expensive as capabilities are added.

Soft sectoring uses a single index hole on the disk to provide a track timing pulse. Sectoring is then determined by software that tells the controller how many pulses to count to locate a sector. The sectors can be defined, therefore, by the system designer. The number of sectors can vary, but for interchange purposes, the industry standard is 16.

Hard sectoring is controlled by hardware detection of sector holes that mark the beginning of each sector. The two standards are 10 and 16 holes per disk, plus a single index hole. In the 16-sector disk, for example, 16 holes are equally spaced around the radius of the disk. The index hole lies between two of these holes. The controller decodes index and sectoring pulses to determine sector location.

A system designer can adopt industry-standard sectoring techniques, or bend them to his own needs. A combination of hard and soft sectoring techniques is often used, or a single track might contain an entire sector.

Two basic track densities are offered: 48 and 96 tpi. The actual number of tracks on each side of a diskette is 40 tracks on a 48-tpi drive and 80 tracks on a 96-tpi drive. A single-sided, 48 tpi drive stores 40 tracks of data on one side of a diskette. A double-sided drive holds twice that capacity, or 80 tracks. A 96-tpi, single-sided drive provides 80 tracks; a double-sided version provides 160 tracks. A 48-tpi, single-sided drive stores 250K bytes of unformatted information on 40 tracks. A 48-tpi, double-sided drive provides twice that capacity, or 0.5M bytes. A 96-tpi, single-sided drive, which has the same number of tracks as a 48-tpi, double-sided drive also provides 0.5M bytes of storage.

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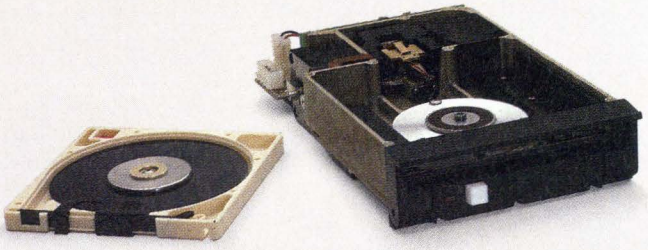

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- Open loop positioning

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CIRCLE NO. 166 ON INQUIRY CARD

Doubling that in a 96-tpi, two-sided drive gives 1M byte of storage. In expanding from 1M byte to 2M bytes, the recording density is doubled without increasing the number of tracks.

If industry interchange is not a requirement, a customized configuration can be developed with higher storage capacity. Because the outer tracks travel faster than the inner tracks, for example, bit density is lower on these outer tracks on standard drives. By increasing the recording frequency, bit density can be kept constant, and, thus, capacity can be increased on outer tracks.

The recording capacity selected is a function of the overall system design. Today, most hobbyist computers primarily use single-sided drives with a 250K-byte capacity. In business computers, on the other hand, higher capacities are normally selected.

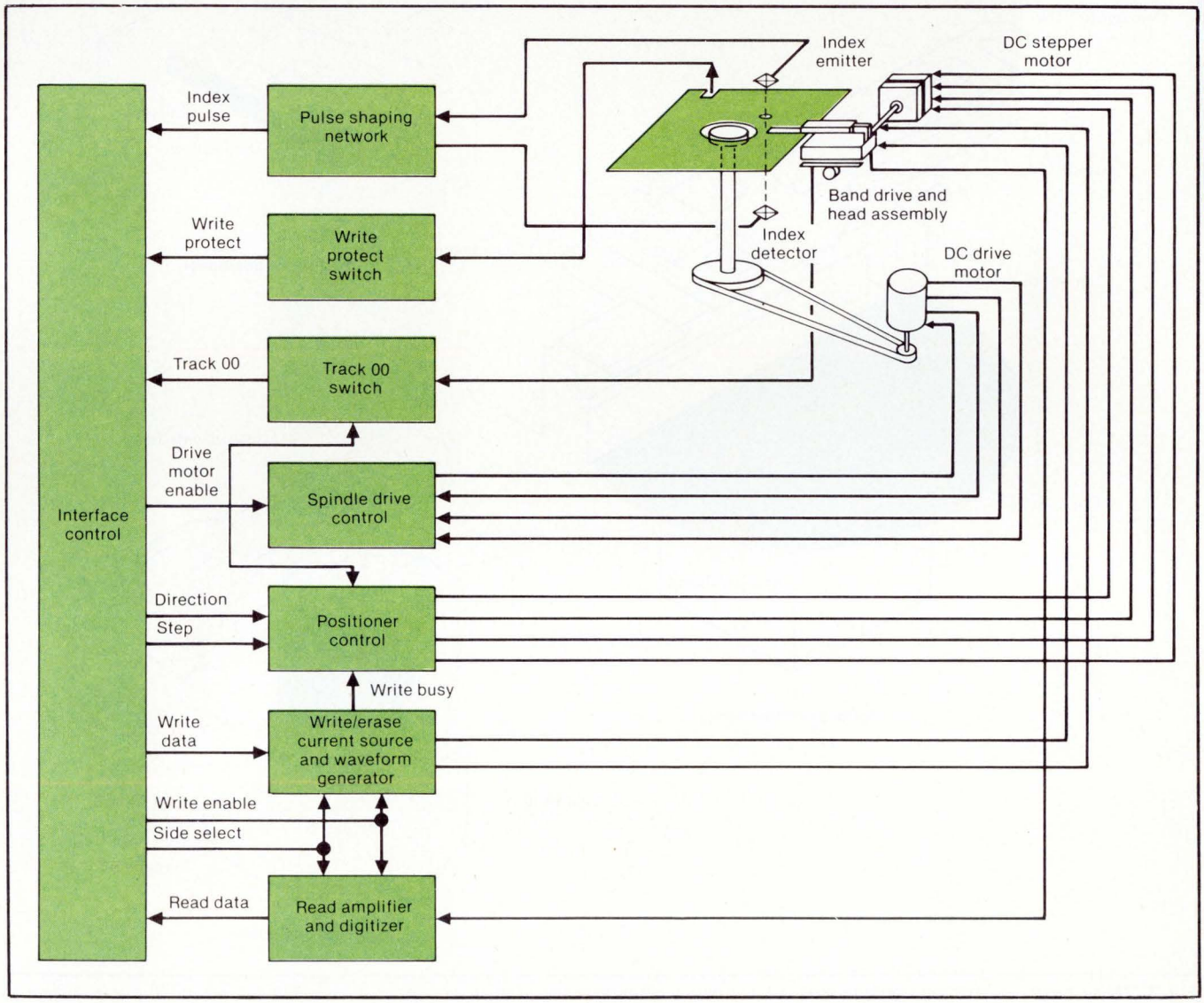
Understanding performance specifications

Computer throughput is directly affected by both the access times and data transfer rates of a disk drive. An understanding of these functions and their interrelationship help system designers select the drive with the best combination of performance parameters.

Standby power consumption, if not specified properly, can make operating costs soar.

A disk drive moves a recording head from one track to another to write or retrieve a file by a command from the controller. The time to accomplish this action is called access time.

Track-to-track access time is a measure of how long it takes the head to move from one track to another; 3 msec. is typical, but longer access times exist. The time



Functional diagram of a typical 5¼-in. drive *includes track seek, track step, write and read functions. Index hole is detected by sensing light from an emitter that helps the controller keep track of sector locations.*

is determined primarily by the mechanical capabilities of the stepper motor to power up and advance to the next track.

After the positioning mechanism has been stepped to a new track, the read/write head requires a head-settling time to stop moving and inform the controller that the data it is reading are valid. In a 96-tpi drive, for example, the head can typically be stepped from one track to the next in 3 msec. If head-settling time is 15 msec., the controller has at least 18 msec. to perform other tasks before returning to retrieve the data. While the minimum head-settling time is 15 msec., this time varies widely as a function of head design.

Access time is a combination of track-to-track access time and head-settling time. Average access time is the number of steps over an entire disk surface, divided by three, plus head-settling time.

The disk rotational speed in all 5¼-in. floppy disk drives is 300 rpm to make interchange practical. This constant rotational speed, when combined with a compatible recording technique, helps ensure that data recorded on one manufacturer's drive can be retrieved on another drive. Average latency time—the time the head must wait for the appropriate point of the track to pass beneath it—is defined as the time of one-half revolution, or 100 msec.

Three techniques to position heads are used in 5¼-in. drives: spiral cam, lead screw and split band (Fig. 4).

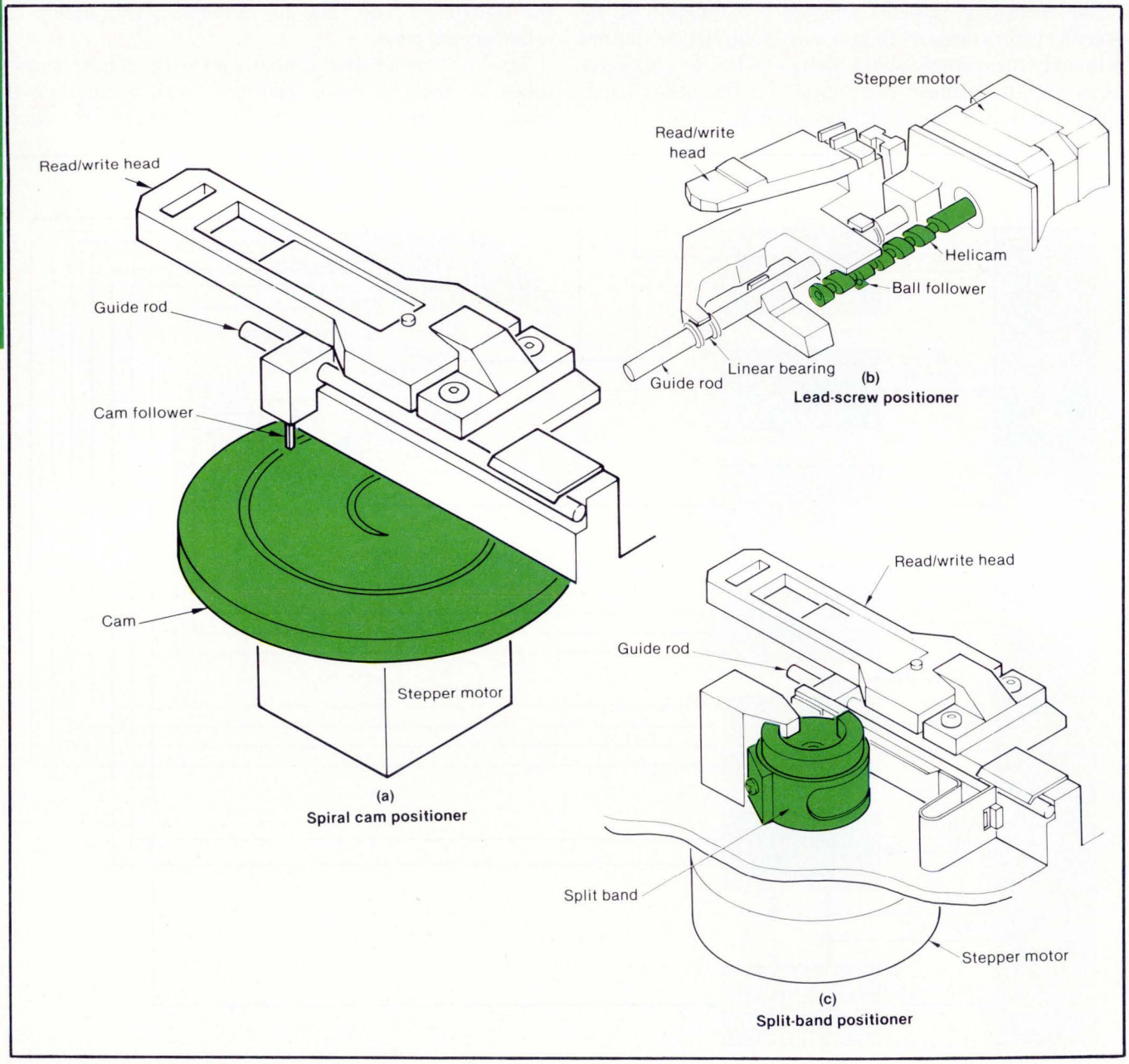


Fig. 4. Three head-positioning mechanisms *are popular in diskette drives. The spiral cam positioner features low cost, but is subject to groove wear leading to positioning errors. The lead-screw technique provides medium speed and accurate positioning, but long-term reliability can again be a problem. The split-band positioner is the fastest and most accurate diskette-positioning mechanism.*

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CIRCLE NO. 167 ON INQUIRY CARD

These positioning mechanisms vitally affect the accuracy, speed and density of a disk drive.

Spiral cams are plastic disks with embedded grooves. Widely used in 5¼-in. drives, they are easy to make and cost effective. While they meet the positioning requirements in a track density of 48 tpi, they do not support the higher accuracies demanded by 96 tpi. In addition, reliability is a problem. Groove wear in a cam can rapidly lead to positioning errors.

A typical lead-screw positioning mechanism has a three-point guidance system, consisting of two linear bearings on the guide rod and a captive ball "outrigger." This three-point system controls head motion and media relationships. Lead screws are accurate, but limited in applications involving long travel, and wearing of the ball follower presents a long-term reliability problem. Typical track-to-track access time is 6 msec.

A split-band positioner basically consists of an anchored metal band wrapped around a capstan. Positioning errors are minimized by accurately grinding the capstan's diameter and eccentricity. The accuracy of this techinque is underscored by its wide use in Winchester disk drives, in which repeatability is most important. The split-band positioner is the fastest of the three widely used positioning mechanisms. Track-to-track access time is typically less than 3 msec., and long-term reliability is inherent.

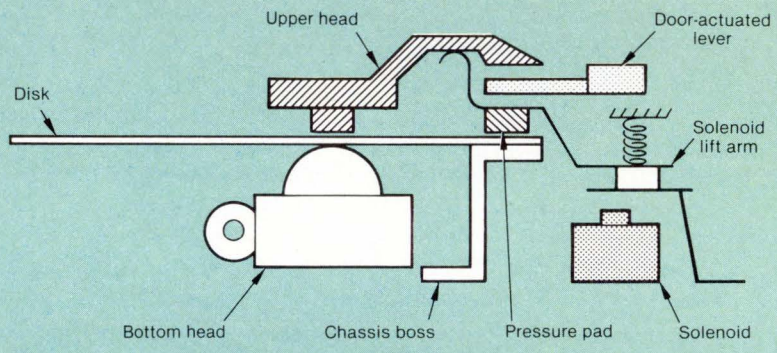
Motor design also affects disk drive performance. In 8-in. drives, a brushless AC spindle motor turns the disk, and a solenoid loads and unloads the recording head on the media (see "Head-load solenoids: worth the cost?" p. below). In contrast, 5¼-in. disk drives use more efficient DC motors that start only when data are to be written or retrieved. The heads always ride on the media surface. It is important to have a motor that accelerates rapidly to full speed. A typical time is 250 msec., although some drives take as long as 1 sec.

The amount of time it takes to transfer a bit from the drive to the controller and into computer memory is the transfer rate. For interchange and controller design, transfer rates are standardized throughout the indus-

HEAD-LOAD SOLENOIDS: WORTH THE COST?

Head-load solenoids were first used in 8-in. floppy disk drives, in which they were needed to reduce head and media wear. They have since found limited application in 5¼-in. drives, in which their usefulness is questionable.

In a typical 8-in. drive, a solenoid is placed on the recording arm. It gently loads the recording head on the spinning disk to write or retrieve data, then unloads it when the access function is completed. Thus, the heads and media receive minimal wear and, theoretically, can last much longer. The media spin continuously while in operation, powered by a long-life AC brushless motor.



There are, however, drawbacks to head-load solenoids. An audible "clicking" or "clacking" sound emanates from the solenoid as it actuates a pin to load the head, which can be disruptive in most office environments. Furthermore, extra power is needed to hold the solenoid down while a head is being loaded, adding to operating costs. The solenoid itself is an additional cost when purchased as an option. And finally, because it's an electromechanical device, the head-load solenoid represents one more component that can potentially fail or cause problems. A stray magnetic field, created when the solenoid couples into the head, can diminish the signal-to-noise ratio, in some cases creating soft errors. Another risk is a "hard landing" as the head is being loaded, causing both head and media damage. Solenoids also go out of adjustment and must be serviced.

Different design problems have brought about different solutions for the read/write function in 5¼-in. drives. A lower power motor is used to rotate the media. To extend the life of the motor, the motor is used when reading or writing data on the diskette. In addition, the heads are designed to be on the media at all times, eliminating the need for solenoids to load and unload the heads. When access is required, the disk spindle motor is turned on. When access is completed, it's turned off. Empirical data have shown that media can last for 6 million wear revolutions. At 300 rpm, this is equivalent to continuous operation for 14 days, 24 hours a day.

The presence of a head-load solenoid poses a special problem in 5¼-in. drives. When the media door is opened, the heads are separated to accept or remove the media. An out-of-adjustment head-load solenoid could keep the head in contact with the media, causing the media to catch on the heads and damage them, or suffer damage itself.

Thus, the problems of head-load solenoids in 5¼-in. drives outweigh the benefits.

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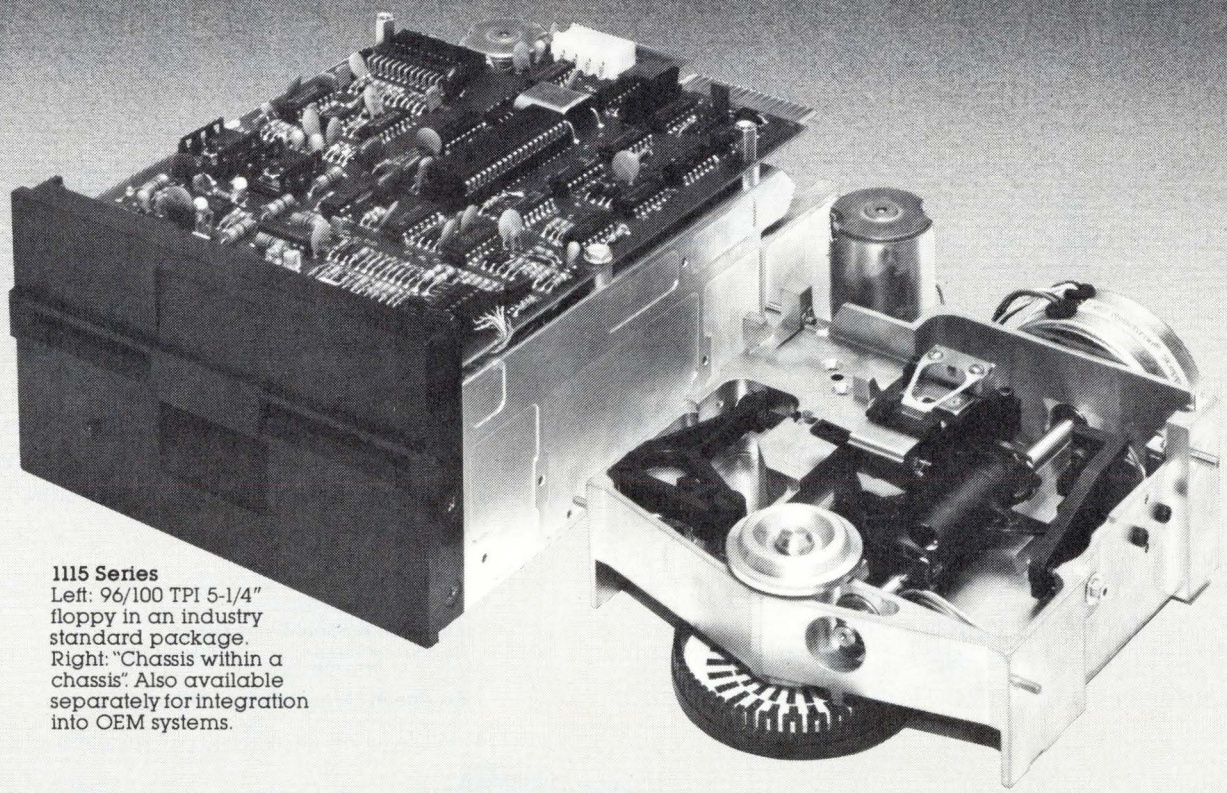

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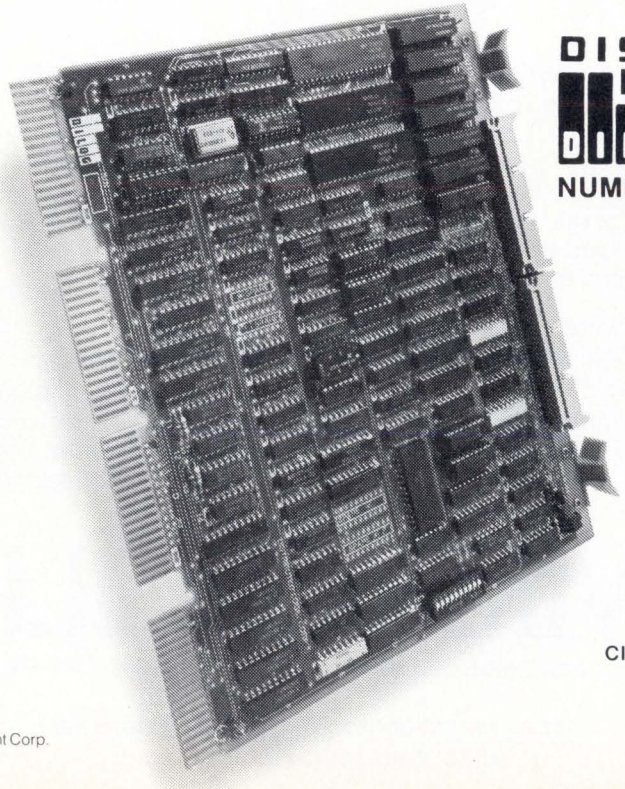

DISTRIBUTED LOGIC CORP.
DILOG
NUMBER 1 FOR DEC-11

CIRCLE NO. 169 ON INQUIRY CARD

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try at 250K bits per sec. Double-density drives, however, have a transfer rate of 500K bps.

Features add sophistication and security

Although size, capacity and throughput are becoming standardized, a system designer can select operational features tailored to his needs. Sophistication and security can be added from an imposing list of available features, including:

- **Write protect,** a standard option on most drives. A write-protect switch senses a special tab on the diskette, and signals the drive that the data are protected and that new data should not be written on the disk. If the controller issues a write-operation command, the switch inhibits write current.
- **Daisy chaining,** a cost-cutting option allowing as many as four disk drives to be hooked on a single controller. The controller addresses individual drives to transfer data.
- **An industry-standard interface,** which allows a user to mix disk drives of different manufacturers on one controller.
- **A high-precision stepper motor,** which is offered to save power. Track position is held by magnetic stepping of the motor, rather than by continuous application of power.

A system designer can adopt standard sectoring techniques, or bend them to his own needs.

- **Software security,** which can be provided by a ready line in several variations. A ready-line signal can indicate that the media door is closed; that the door has been reclosed following media insertion, alerting the controller that the media has been disturbed, and to take special action; or that the drive is ready and has been selected, index pulses have been detected, and the door is closed.
- **A disk-in-place switch,** which provides software security and lowers overhead costs by verifying the absence or presence of media before access is attempted. Inappropriate media access can be prevented through a controller-activated solenoid that engages a pin to lock the media door. This software-security option also saves controller overhead time.
- **A motor start,** which improves disk centering and eliminates media pinching. As the media door is closed, the spindle motor is turned for a few seconds while the centering cone engages the media. Centrifugal force pushes the media out against the spinning hub and centers it properly.

Most manufacturers also offer a 5¼-in. drive without electronics in mechanics-only versions. They are also available with servo board only, or with complete electronics including both servo and logic boards.

Power consumption is also an important selection criterion. Operating power varies significantly among manufacturers, and should be figured as a fixed cost. Standby power consumption, however, if not specified properly, can make operating costs soar. Standby power is power that keeps the drive operating when the spindle motor has been turned off and the stepper motor is not accessing. A cost-saving solution in multi-drive systems consists of a switch that turns a drive's power off when other drives are being accessed, and on again when access is required.

Reliability: key to long-term performance

Common failures in diskette drives fall into the categories of soft and hard errors, as well as mechanical and electrical component failures.

Positioning mechanisms vitally affect the accuracy, speed and density of a disk drive.

A soft error is a read error that is recovered in a specified number of recovery attempts. An industry-accepted rate is one error in 10^9 bits. There are several error-recovery techniques. One is for the controller to "sit" on a track, wait for the appropriate sector to come under the read/write head a number of times and recover the error. A second is for the controller to move off to other tasks and return a specified number of times to recover the data. If the error can't be recovered in the pre-determined number of retries, say 10, the error is considered a hard error. Hard-error rates are typically one error in 10^{12} bits. Write-error rates are not typically listed on specification sheets. But error rates are a function of the media itself.

Mean-time-between-failure rates are normally listed for several elements of a drive. Heads are generally specified for 20,000 hours of life, logic cards are specified for an average of 15,000 hours, and spindle motors typically boast an MTBF figure of 2000 power-on hours in worst-case applications for carbon-brush motors. The mean-time-to-repair figure for a typical drive is 30 min. or less. Empirical data substantiate this figure. A major variable is the expertise of a vendor's service technician who can shave minutes off this figure. Serviceability should be evaluated on the difficulty of replacing components such as the spindle motor belt and the logic boards. Head alignment, too, should be a simple task.

Although most 5¼-in. diskette manufacturers claim that their drives require no preventive maintenance, this is simply not the case. If a drive is maintained in a

clean environment and the media are handled properly, the need for preventive maintenance is reduced. However, typical handling procedures often result in damage. Spilling coffee on the media, for example, can loosen oxide from the media, which can be deposited on the head, resulting in rapid degradation of the head and the media. Head cleaning is the logical maintenance step. Preventive maintenance should be directed not only to the drive, but also to its environment.

A manufacturer should be evaluated for a spare and service policy that matches a system integrator's needs. An integrator should look for a vendor's commitment to stock recommended spares and to service spares in a mutually agreeable period of time. In addition, the manufacturer's ability to provide a convenient repair depot, on-site support and assistance in establishing a repair facility are important.

Upgrading is easy, but consider data recovery

Standardization of many 5¼-in. diskette drive elements has made upgrading easy. A user can upgrade with drives from several manufacturers in one system, raising capacity from 250K to 2M bytes. But data-recovery and software compatibility are potential problems.

The transition to higher performance drives can tax a controller. Doubling the capacity from 1M byte to 2M bytes also means doubling the data transfer rate from 250K to 500K bits per sec. If this rate is beyond a controller's capabilities, data recovery must be redesigned.

Upgrading from a single-sided drive to a double-sided unit requires changes in operating-system hardware. Because data are recorded on both sides, a "side select" signal on an interface must be activated to reach the second recording head. Software upgrading is also necessary to handle the increased capacity.

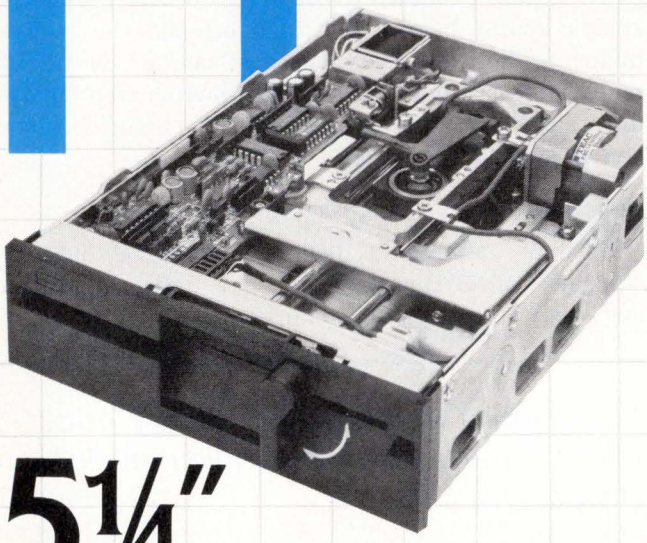
A final word: scrutinize the trade-offs

Few manufacturers offer every available performance characteristic in a single package. Performance enhancements can be made, but if one parameter in a drive has to be added or improved, a trade-off is almost always necessary. For example, a standard spindle motor might be exchanged for a longer life brushless motor. The brushless motor, however, may not have the necessary starting torque to get the disk to its rotational speed in the specified starting time. System designers and integrators should be keenly aware of the consequences of such trade-offs. □

Bill Williams is floppy disk drive product line manager for Tandon Corp., Chatsworth, Calif.

5¼-in diskette drives

HALF HIGH



5¼"
Floppy Disk Drives
TEAC FD-55 Series

AT 1⅝" HIGH, TEAC FD-55 SERIES 5¼" FLOPPY DISK drives use half the space and run cool at half the power of conventional drives. High-reliability, low-noise brushless DC motors provide an MTBF of over 10,000 hours, backed by a one-year parts and labor warranty.

FD-55A	FD-55B	FD-55E	FD-55F
• 48tpi	• 48tpi	• 96tpi	• 96tpi
• 40 track	• 40 track	• 80 track	• 80 track
• 250KB	• 500KB	• 500KB	• 1MB
• single side	• double side	• single side	• double side

Power Requirements:
DC +12V ±5% 0.3A typical, 0.7A max.
DC + 5V ±5% 0.5A typical, 0.7A max.

Phone, write or wire TEAC Corporation of America for complete technical data, price and delivery.

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CIRCLE NO. 170 ON INQUIRY CARD

Introducing the first removable Whitney technology disk drive for OEMs.

Cartridge convenience with fixed media performance and reliability in an 8-inch, fixed/removable drive.

- **50 Mbytes Total Storage**
- **25 Mbyte ANSI Standard Cartridge**
- **35 msec average access**
- **CDC Lark™ compatible SMD interface**
- **8-inch floppy envelope**

Now there's a disk drive with the combination of speed, capacity, reliability and packaging efficiency to complement your high-performance mini- or microcomputer based system.

It's the Arapahoe 7110 from Amcodyne.

Arapahoe features advanced Whitney head suspension and read/write technologies derived from the latest generation of mainframe disk drives. Improved aerodynamic stability, superior head/disk compliance and higher signal-to-noise ratio result in data reliability that is substantially better than that attainable with Winchester technology.

Arapahoe incorporates a microprocessor-controlled/embedded-servo system to eliminate the head/disk alignment problems which handicapped early cartridge disk drives. The microprocessor directs all head-movement operations and computes the runout profile for each cartridge. The result is fast, accurate seeks and absolute tracking accuracy for cartridge interchangeability.

Reliability is further assured by Arapahoe's proprietary head-loading mechanism and positive-pressure clean-air system. When a cartridge is loaded, Arapahoe's heads are held off the disk until the cartridge is purged to a fixed-media cleanliness level. Only then are the heads lowered into flying position. Together, these features mean you can employ Arapahoe with confidence in a wide variety of office, laboratory or industrial environments.

For Arapahoe product specifications and a free monograph on Whitney, the technology that's replacing Winchester in high performance disk, contact Amcodyne.

Amcodyne

Amcodyne, Inc.
805 South Lincoln Street
Longmont, Colorado 80501
303-772-2601

See us at
COMDEX
November 8-11, 1982
Amsterdam
November 29-December 2, 1982
Las Vegas

CIRCLE NO. 171 ON INQUIRY CARD

5¼-IN. DISKETTE DRIVES

Company Model	Single-sided (Y/N)	Double-sided (Y/N)	Capacity (K bytes)	Avg. access time (msec.)	Transfer rate (K bytes/sec.)	Tracks/ surface	Tracks/ in.	Price ($)	Dimensions (H x W x D, in.)
ALPS ELECTRIC CO., LTD.									
FDM2000	N	Y	256		0	40	48		1.6 x 5.8 x 8.0
AFD211	Y	N	250	156	250	40	48	110	1.61 x 5.75 x 8
AFD212	N	Y	500	156	250	80	48	150	1.61 x 5.75 x 8
AFD221	Y	N	500	94	250	80	96		1.61 x 5.75 x 8
AFD222	N	Y	1000	94	250	160	96		1.61 x 5.75 x 8
ANDERSON JACOBSON, INC.									
AJ460	Y	N	204	370	0	10	40	1595	7 x 12 x 15.5
APPLE COMPUTER									
Disk II	Y	N	140	0	125	35	48	645	3.3 x 5.8 x 8.0
Disk III	Y	N	140	0	125	35	48	495	4.1 x 6.3 x 8.8
BASF									
6106	Y	N	250	156	250	40	48		2.1 x 5.8 x 7.5
6108	N	Y	500	156	250	400	48		2.1 x 5.8 x 7.5
6118	N	Y	1000	158	250	80	96		2.1 x 5.8 x 7.5
C. ITOH ELECTRONICS, INC.									
YD-380T	N	Y	1600	91	500	77	96	350, Q1000	1.6 x 5.8 x 8
COLUMBIA DATA PRODUCTS									
400	Y	N	180	463	250	35	48	2195	5.3 x 7.0 x 13.5
COMMODORE BUSINESS MACHINES									
2031	Y	N	170		125	35	48	595	
4040	Y	N	330		125	35	48	1295	7.1 x 15.0 x 15.5
8050	Y	N	1050		125	77	96	1795	7.1 x 15.0 x 15.5
8250	N	Y	2100		125	77	96	2195	7.1 x 15.0 x 15.5
CONTROL DATA CORP.									
9408	Y	Y	125/250	80	125/250	40	48	175, Q2500	3.4 x 5.9 x 8.0
9409	Y	Y	250/500	80	125/250	40	48	230, Q2500	3.4 x 5.9 x 8.0
9409T	N	Y	500/1000	132	125/250	80	96	310, Q2500	3.4 x 5.9 x 8.0
IRWIN/OLIVETTI, INC.									
FD501	Y	N	250	333	250	40	48	176, Q500	3.3 x 5.8 x 8.0
FD591	Y	N	500	80	250	80	96	275, Q500	3.3 x 5.8 x 8.0
FD592	Y	Y	1000	80	250	80	96	324, Q500	3.3 x 5.8 x 8.0
MICRO PERIPHERALS, INC.									
101	Y	N	525		250	84	100	255, Q500	3.3 x 5.8 x 7.5
102	N	Y	1050		250	168	100	280, Q500	3.3 x 5.8 x 7.5

5¼-IN. DISKETTE DRIVES

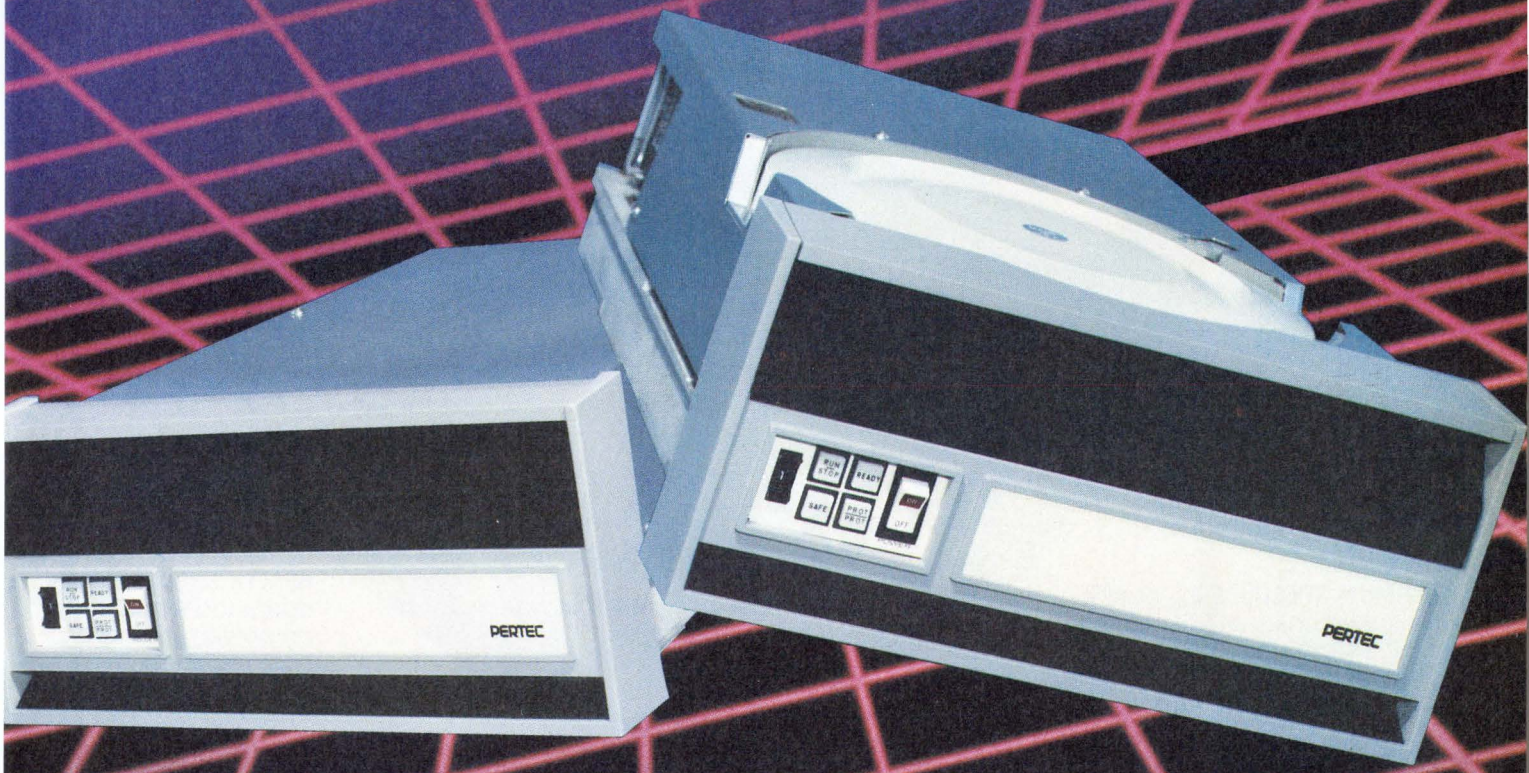
Company Model	Single-sided (Y/N)	Double-sided (Y/N)	Capacity (K bytes)	Avg. access time (msec.)	Transfer rate (K bytes/sec.)	Tracks/ surface	Tracks/ in.	Price ($)	Dimensions (H x W x D, in.)
51	Y	N	250		250	40	48	180, Q500	3.3 x 5.8 x 7.5
52	N	Y	500		250	80	48	255, Q500	3.3 x 5.8 x 7.5
91	Y	N	500		250	80	96	250, Q500	3.3 x 5.8 x 7.5
92	N	Y	1050		250	160	96	330, Q500	3.3 x 5.8 x 7.5
MICRO-SCI									
A143	N	Y	572		250	140	96	799	3.8 x 6.0 x 8.8
A2	Y	N	143		250	35	48	479	3.8 x 6.0 x 8.8
A3	Y	N	143		250	35	48	449	3.8 x 6.0 x 8.8
A40	Y	N	164		250	40	48	479	3.8 x 6.0 x 8.8
A70	Y	N	286		250	70	96	599	3.8 x 6.0 x 8.8
A73	Y	N	286		250	70	48	649	3.8 x 6.0 x 8.8
MICROPOLIS CORP.									
1015-II	Y	Y	960		0	77	100		3.2 x 5.8 x 7.8
1015-IV	N	Y	960		0	77	100		3.4 x 5.9 x 8.5
1015-V	Y		500		0	80	96		3.4 x 5.9 x 8.5
1015-VI	N	Y	1000		0	80	96		3.4 x 5.9 x 8.5
1016-II	Y	N	585		0	77	100		3.4 x 5.6 x 8.5
1016-IV	N	Y	1170		0	77	100		3.4 x 5.9 x 8.5
1117-II	Y	N	1200		0	96	100		3.4 x 5.9 x 8.3
1117-IV	N	Y	2175		0	100	100		3.4 x 5.9 x 8.3
1117-V	Y	N	1113		0	89	96		3.4 x 5.9 x 8.3
1117-VI	N	Y	2025		0	89	96		3.8 x 5.9 x 8.3
MITSUBISHI ELECTRIC CORP.									
M4853	Y		1000	94	0	80	96		1.6 x 5.8 x 8.0
M4854		Y	1600		0	77	96		1.6 x 5.8 x 8.0
MITSUBISHI ELECTRONICS AMERICA, INC.									
M4853	Y	Y	1000	94	31	80	96	300, Q1000	1.6 x 5.8 x 8
M4854	Y	Y	1600	91	63	77	96	370, Q1000	1.6 x 5.8 x 8
PERTEC COMPUTER CORP.									
FD200	Y	Y	250		0	40	48		3.3 x 5.8 x 8.0
FD250	Y	Y	438		0	35	48		3.3 x 5.8 x 8.0
PHILLIPS DATA SYSTEMS									
H1100	N	Y	438		0	35	48		2.3 x 5.9 x 8.4

5¼-IN. DISKETTE DRIVES

Company Model	Single-sided (Y/N)	Double-sided (Y/N)	Capacity (K bytes)	Avg. access time (msec.)	Transfer rate (K bytes/sec.)	Tracks/ surface	Tracks/ in.	Price ($)	Dimensions (H x W x D, in.)
QUME CORP.									
Qumetrack 542	Y	Y	250		0	40	48		3.4 x 5.8 x 8.0
Qumetrack 592	N	Y	1000		0	80	96		3.3 x 5.8 x 8.3
REMEX									
Pico RFD 480	Y	Y	500	80	250	40	48	210, Q2500	2.1 x 5.8 x 8.0
Pico RFD 960	Y	Y	1000	147	250	80	96	255, Q2500	2.1 x 5.8 x 8.0
Pico RFD 961	Y	Y	500		0	80	96		2.1 x 5.8 x 8.0
SHUGART ASSOCIATES									
SA200	Y	N	256	93	250	40	48	160, Q200	2.0 x 5.8 x 7.9
SA400	Y	N	256	275	250	40	48	185, Q200	3.3 x 5.8 x 8.3
SA405	Y	N	256	93	250	40	48	190, Q200	3.3 x 5.8 x 8.3
SA410	Y	N	512	158	250	80	96	270, Q200	3.3 x 5.8 x 8.3
SA450	N	Y	512	275	250	40	48	235, Q200	3.3 x 5.8 x 8.3
SA455	N	Y	512	94	250	40	48	165, Q5000	3.3 x 5.8 x 8.3
SA460	Y	N	1000	158	250	80	96	335, Q200	3.3 x 5.8 x 8.3
SA465	N	Y	1000	94	250	80	96	195, Q5000	3.3 x 5.8 x 8.3
SIEMENS CORP.									
FDD 100-5	Y	Y	250		250	40	48	340	3.3 x 5.8 x 8.3
111-5			500	20	250		48	450	
121-5			500	5	250		96	350	
FDD 196-5	Y	Y	500		0	80	96		3.3 x 5.8 x 8.3
FDD 200-5	Y	Y	500		0	40	48		3.3 x 5.8 x 8.0
211-5			500	5	250		48	450	
222-5			1000	5	250		96	450	
FDD 296-5	Y	Y	1000		0	80	96		3.3 x 5.8 x 8.3
TANDON CORP.									
TM100-1	Y	N	250		250	40	48	200, Q500	3.2 x 5.8 x 8.0
TM100-2	N	Y	500		250	40	48	245, Q500	3.2 x 5.8 x 8.0
TM100-3	Y	N	500		250	80	96	245, Q500	3.2 x 5.8 x 8.0
TM100-3M	Y	N	0		250	80	100		3.2 x 5.8 x 8.0
TM100-4	N	Y	1000		250	80	96	330, Q500	3.2 x 5.8 x 8.0
TM100-4M	N	Y	0		500	80	100		3.2 x 5.8 x 8.0
TM101-4	N	Y	1000		250	80	96	330, Q500	3.2 x 5.8 x 8.0
TM102-2	N	Y	2000		500	80	96	430, Q500	3.2 x 5.8 x 8.0
TM50-1	Y	N	250		250	40	48		1.6 x 5.8 x 8.0
TM50-2	N	Y	500		250	40	48		1.6 x 5.8 x 8.0
TM55-2	N	Y	500		250	40	48		1.6 x 5.8 x 8.0
TM55-4	N	Y	1000		250	80	96		1.6 x 5.8 x 8.0

You still have a choice in cartridge disk drives.

Choose the best.



The Pertec D-3000 Series

- Standard interchangeable media. Mature, proven 14″ disk cartridge.
- Backed by more than 10 years experience building and supporting disk cartridge drives.
- 12 to 25 megabytes (unformatted) capacity in 2315 (front-loading) and 5440 (top-loading) models.
- Double your system capacity. Add *one* drive, at far less cost than 2 drives, by simply daisy chaining or substituting existing drives in the same space.
- Standard interface; software compatibility.

Sure, we're still making cartridge disk drives, utilizing our experience and proven technology. And we are delivering a better product. Why not? We've been doing it longer than most anyone!

And if you need higher capacities, up to 84 megabytes, consider Pertec's new TrakStar family.

Write or phone for our D-3000 literature package. Pertec Computer Corp., P.O. Box 2198, Chatsworth, CA 91311, or call (213) 999-2020. In Europe, contact Pertec International, 10 Portman Road, Reading, Berkshire RG3 1DU. Tel. 734-582115.

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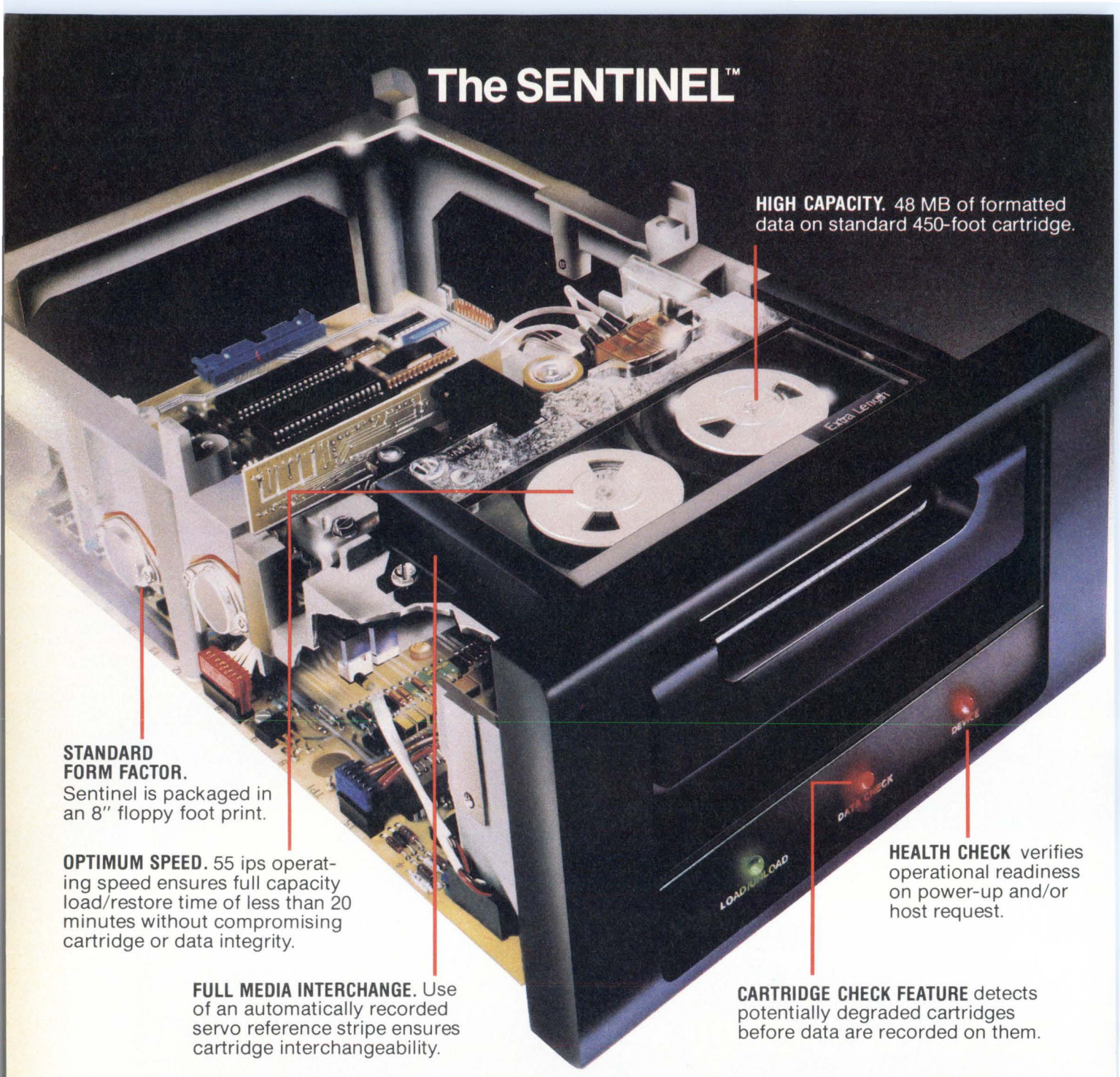
CIRCLE NO. 172 ON INQUIRY CARD

The SENTINEL™



HIGH CAPACITY. 48 MB of formatted data on standard 450-foot cartridge.

STANDARD FORM FACTOR. Sentinel is packaged in an 8" floppy foot print.

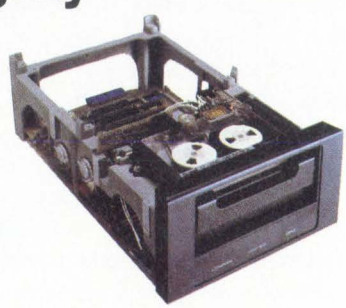
OPTIMUM SPEED. 55 ips operating speed ensures full capacity load/restore time of less than 20 minutes without compromising cartridge or data integrity.

FULL MEDIA INTERCHANGE. Use of an automatically recorded servo reference stripe ensures cartridge interchangeability.

HEALTH CHECK verifies operational readiness on power-up and/or host request.

CARTRIDGE CHECK FEATURE detects potentially degraded cartridges before data are recorded on them.

Finally—high capacity plus data integrity in a ¼-inch cartridge streamer.



The Model 92190 Sentinel cartridge streamer delivers the data capacity needed to back up even today's higher-capacity 8" fixed disk drives. With a data rate (55 KBS) optimized for system requirements. Plus an optional ECC feature for applications requiring extremely high data integrity. For more information, call your local Control Data OEM Sales Representative or write: OEM Product Sales, HQN08H, Control Data Corporation, P.O. Box 0, Minneapolis, MN 55440.

CONTROL DATA

Addressing society's major unmet needs as profitable business opportunities.

CIRCLE NO. 173 ON INQUIRY CARD

5¼-IN. DISKETTE DRIVES

Company Model	Single-sided (Y/N)	Double-sided (Y/N)	Capacity (K bytes)	Avg. access time (msec.)	Transfer rate (K bytes/sec.)	Tracks/ surface	Tracks/ in.	Price ($)	Dimensions (H x W x D, in.)
TEAC CORP.									
FD-50B (250K)	Y	Y	250		0	40	48		3.3 x 5.8 x 8.0
FD-50B (500K)	Y	Y	500		0	77	100		3.3 x 5.8 x 8.0
FD-50C	Y	Y	481		0	77	100		3.3 x 5.8 x 8.0
FD-50E	Y	Y	500		0	80	96		3.3 x 5.8 x 8.3
FD-50F	Y	Y	1000		0	80	96		3.3 x 5.8 x 8.0
TECHTRAN INDUSTRIES									
950X	Y	N	200	800	268	35	48	1285	5.3 x 10 x 11.8
980XX	Y	N	400	900	268	70	48	1525	5.3 x 10 x 11.8
981X	Y	N	200	800	268	35	48	1925	5.3 x 10 x 11.8
TOSHIBA CORP.									
ND-01	Y	Y	1094		0	35	48		3.3 x 5.8 x 8.0
ND-02D	Y	Y	438		0	35	48		3.3 x 5.8 x 8.0
Y-E DATA, INC.									
YD-274	N	Y	500	281	250	40	48		3.3 x 5.8 x 8.0
YD-280	N	Y	1000	95	250	80	96		3.3 x 5.8 x 8.0
YD-380T	N	Y	1600	91	500	77	96		1.6 x 5.8 x 8.0

Delta makes your deliveries DASH.

Delta DASH® delivers the same day to over 90 cities across the U.S and abroad, covering 10,000 communities. Why get that small package delivered tomorrow when you can DASH it today? DASH (Delta Air Lines Special Handling) delivers packages up to 70 lbs . . . to over 10,000 communities. So give us a ring at the Delta Marketing Office in the city nearest you. Or call DASH at (800) 638-7333 for pick up or delivery.

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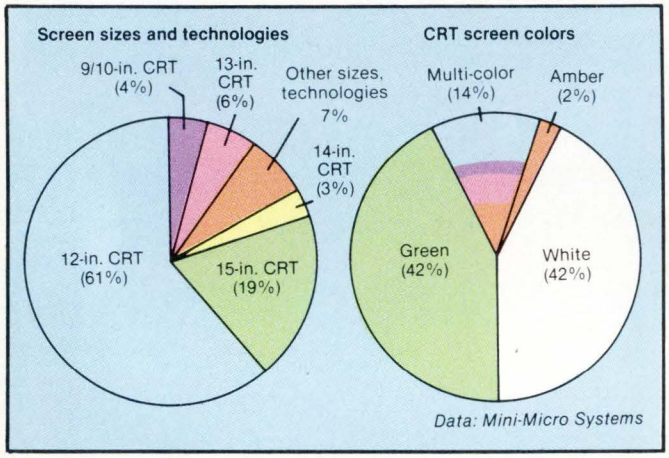
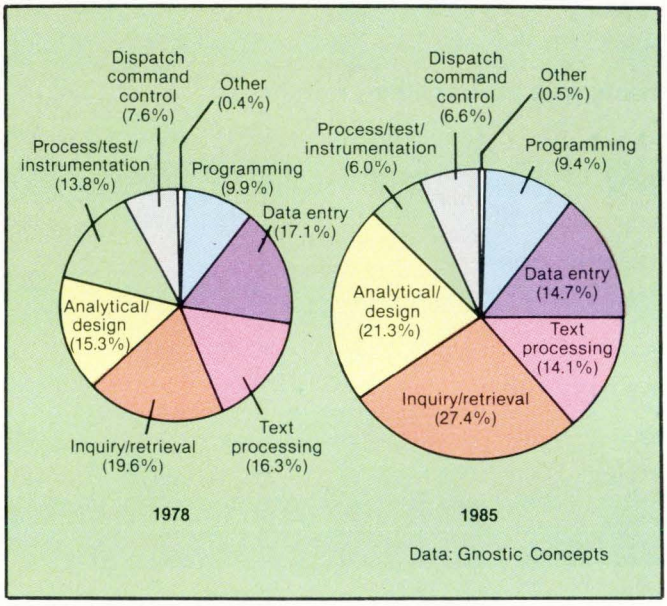
DELTA AIR CARGO. READY ALL·AROUND.

Alphanumeric terminal market overview



Displays are bigger and easier on the eyes. *Diagonal 12-in. displays are built into nearly two-thirds of today's terminals, but many of the newer units offer 15-in. and larger displays. Green phosphor screens are standard on as many terminals as white ones are, and green is a more popular option. Amber screens have yet to catch on, but color screens are quickly gaining popularity as the micros and memory needed to run them get less expensive.*

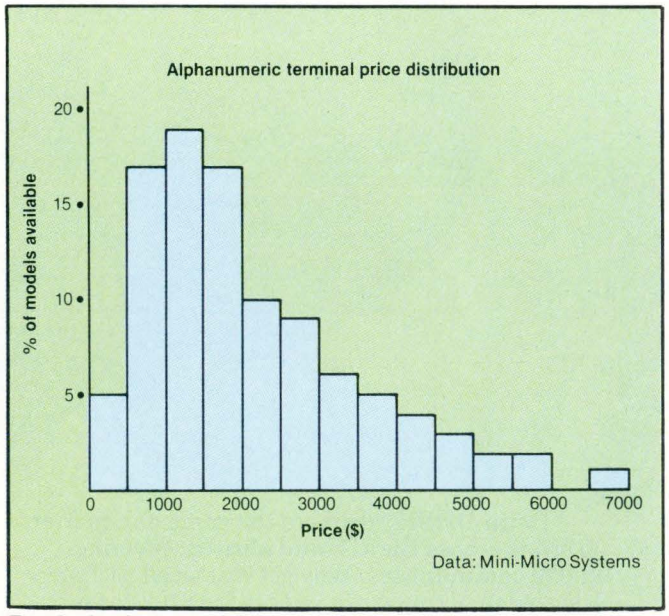


Display terminal applications are changing *but promise solid futures for all terminal types. The two fastest growing applications are good examples: inquiry/retrieval applications are served by dumb and low-end smart terminals, and analytical/design applications are served by intelligent terminals, many with graphics and color capability.*

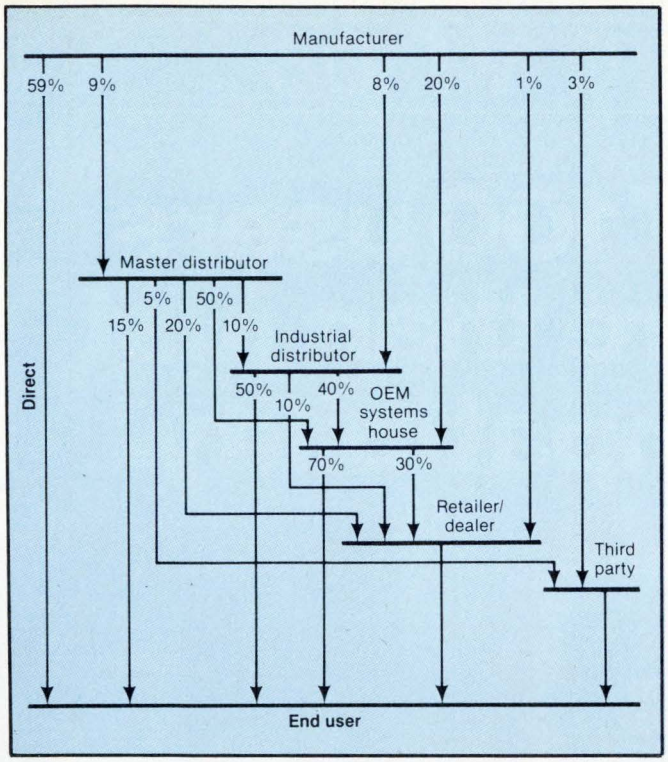
The alphanumeric terminal market had a relatively calm year. Competition was tougher than 1981, but technical innovations were fewer and less spectacular than in previous years. The definitions that have characterized terminal types are becoming increasing blurred. With distribution channels becoming more numerous, thanks to retailers, mail-order suppliers and industrial distributors, market analysts have a tougher time, but buyers have more options.

The terms "dumb terminal" and "low-end terminal" used to mean the same thing, but because of rampant price cutting, the less-than-$1000 low end now encompasses a number of smart or editing terminals. At the high-end, distinctions between intelligent terminals and desk-top microcomputers blur as more micros gain flexible communications capabilities and as micro sales induce terminal vendors to re-label their high-end terminals as microcomputer *systems*.

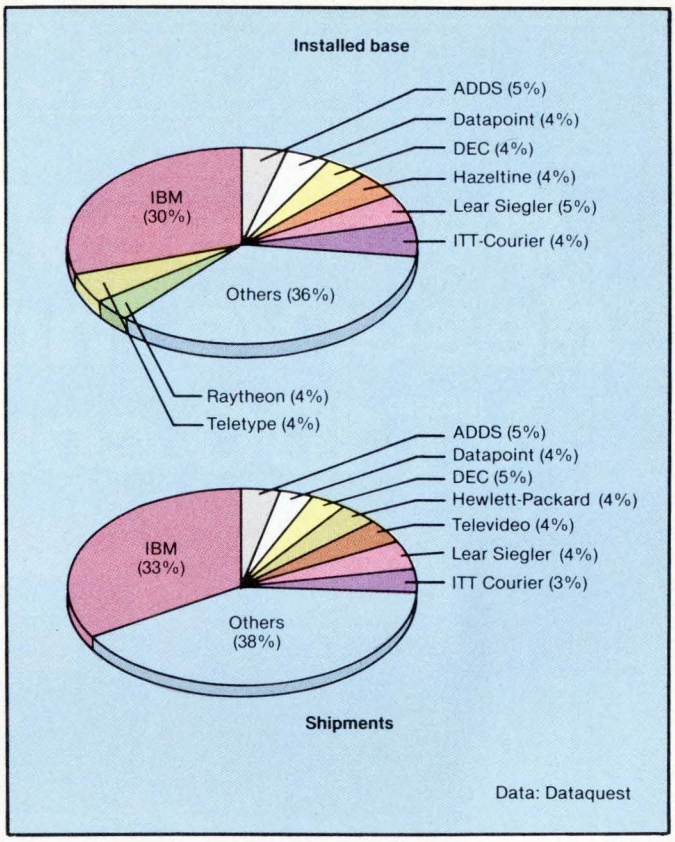
Gnostic Concepts estimates the installed base of terminals at 3.4 million units, and Dataquest estimates that 1 million alphanumeric terminals will be sold in the U.S. alone this year. By 1985, annual U.S. shipments should top 2 million units. The U.S. accounts for roughly half of annual world shipments, but its share will fall to roughly 48 percent by 1985, according to Creative Strategies International.



Terminal prices are falling and becoming more homogeneous. *Taken from the product tables that follow, these data mirror the intense competition in the dumb and low-end editing markets in which features are standardized, and price differentials of only a few percentage points affect large- and small-volume buying decisions.*



An alphanumeric CRT terminal distribution model *developed by Gnostic Concepts, Menlo Park, Calif., is evidence of the maturity of the terminal market. According to Gnostic, direct mail, telemarketing and retail sales methods will gain importance in the future. Even today, though, more than half of all alphanumeric terminals are sold directly by manufacturers to end users.*



The 1981 terminal market shares *reveal that IBM still sells more terminals than the six next-largest vendors combined. With 1981 shipments of roughly 1 million units, though, even a tiny share can mean huge revenues.*

Intelligent terminals shipments

Year	Units	Price ($000)
1976	73,000	324,516
1977	133,000	624,036
1978	163,000	764,796
1979	165,000	774,180
1980	206,000	1,067,080
1981	307,000	1,590,777
1982	420,000	2,196,190
1983	576,000	3,031,638
1984	789,000	4,184,934
1985	1,081,767	5,776,629

Data: Frost and Sullivan

Intelligent-terminal shipments have flourished *as a result of their local processing power and flexible approach to emulating older, large-volume terminals. In a recent survey, Frost and Sullivan concluded that, thanks to a 1980 installed base of 820,000 units and a 37-percent projected annual growth rate, "programmable terminals may lead into distributed data processing rather than the reverse."*

The numerous market-research houses tracking the terminal market estimate different annual market growth rates, but most agree that intelligent terminals sales will grow the fastest (35 to 40 percent revenue growth) followed by smart terminals (20 to 30 percent) and dumb terminals (10 to 20 percent). Demand for alphanumeric terminals of every capability will be fueled by distributed data processing, sales of new multi-user microcomputers and new value-added communications networks such as videotex, The Source, Prestel and Dialog.

The research firms are also in relative agreement on who the leaders are. IBM Corp. is far and away the leader in installed base and in annual shipments, with five or six times the shipments of its closest competitor. The top 10 or so suppliers account for four-fifths of annual sales. Terminal industry revenues are large enough, though, that even a fraction of a percent of market share can sustain a new entrant.

Technologically, the industry followed through on the promises of 1981. Ergonomics got more than lip service as easy-to-read, easy-to-use terminals appeared from U.S. as well as European manufacturers. The CRT promises to remain the dominant display technology through the late 1980s. The standard storage media for intelligent terminals are 8- and 5¼-in. diskette drives, but the new micro-diskette technologies hold great promise. Intelligent-terminal memory capacities average 64K bytes, but are growing as memory prices fall. Many of 1982's technological promises are related to portable terminals. They are one of the more glamorous terminal types and are usually programmable, but their portability imposes design limitations that affect prices and user-friendliness. The first 11 months of 1982 have been quiet for the terminal industry, but if even half the rumors of color, portability, intelligence and ever lower prices to appear at Comdex this month are true, things should heat up again in early '83. □

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It starts with ANSI functionality and DEC software compatibility, and extends that even further by offering eight pages of display memory to relieve the interactive user of the need to generate unnecessary hardcopy printouts and provide the application developer with a powerful tool for applications requiring multiple formats and storage of large volumes of text; by enabling users to permanently configure a terminal for their needs or applications; by providing functionality designed to improve the effectiveness of slow-speed applications; by enabling users to create true windows within display memory; by providing programmable function keys which transmit data and/or execute terminal commands; by providing up to three additional communications ports for connection to other peripherals and computers; by providing flexible user networking functionality for use in a wide range of different applications; and by doing much more.

VT100 compatibility and ANSI functionality. Add it to the *concept* Display Terminal's 132-column performance, in ASCII or APL/ASCII models, with multiple computer capabilities, windowing, programmable function keys, and much more, and you can see why Human Designed Systems has given terminals a new meaning...and that means true economy.

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CIRCLE NO. 174 ON INQUIRY CARD

How to select a video terminal

LISA KINNEMAN, Digital Equipment Corp.

A buyer must match a terminal's communications, ergonomics, functions and reliability to the application

The one peripheral device necessary to the operation of most computer systems is a terminal. From the smallest personal computers to the largest multi-user, time-sharing systems, terminals form the communication channel between a user and a system.

The most commonly used terminal is a video terminal. In multi-user systems, each user generally has his own terminal, while one or two printing devices can serve more than a dozen users. In single-user systems, a video terminal is generally the only interactive communication device, with a satellite hard-copy device used for permanent records. The choice of video terminals thus becomes extremely important to minicomputer and microcomputer system integrators and dealers.

Because terminals on the market have a wide range of prices and features, there is no such thing as a "perfect" terminal. Every astute buyer can, however, ensure that a terminal provides the right combination of operating and reliability features for his applications.

Digital's VT-05 terminal, *one of the early "glass teleprinters," featured upper-case characters only, cursor positioning and on-line/local selection. Video output supported slave monitors.*

Basic considerations

Terminals have traditionally been categorized as "dumb," "editing" or "intelligent," although these labels vary with the manufacturer and the user, and the distinctions between them are increasingly blurred. Rather than selecting a terminal on the basis of such arbitrary classifications, the purchaser should determine which terminals meet the basic application requirements.

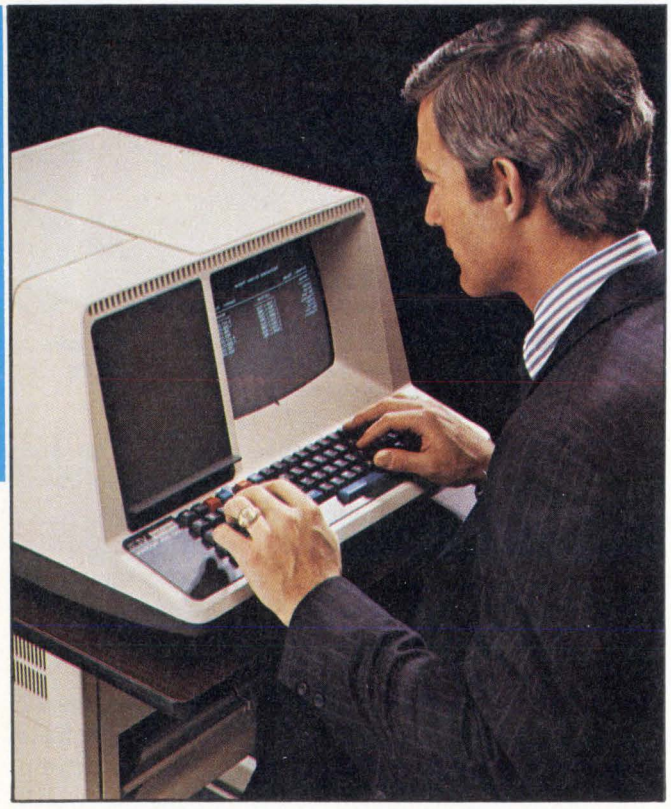
Even the most basic terminals generally provide some control over communications. Transmission and receiving speeds, generally expressed as baud rates, can normally be set manually, with most terminals providing transmit and receive speeds between 110 and 9600 baud in discrete intervals. Some terminals have switches for half- or full-duplex communications.

Terminals can be used locally, connected directly to a computer system, or remotely, through a communications carrier. If a terminal is used with a remote hookup, its modem-control support should be investigated. Most terminals have an EIA RS232C-compatible interface for input/output, and some have provisions for a 20-mA current-loop interface. Most video terminals communicate asynchronously using ASCII characters. Some perform block-mode transmission, in which editing is performed locally and pre-edited data are transmitted.

Some applications, such as multi-screen airport reservation systems, require an output port that can

couple slave video monitors to the terminal. Most monitors require an EIA RS170-compatible interface. This arrangement can also be used effectively in computer-aided instruction applications. A printer port provides local hard copy, often without host intervention.

Most terminals use chip-level controller(s) to perform some operations. The earliest terminals used standard electrical switches to change terminal characteristics. By using special-purpose control logic, often microprocessor-based, a variety of terminal characteristics can be specified interactively from the keyboard. Such adjustments include local echo, numbers of characters per line, receive and transmit speed, on-line/local, tab settings, wraparound and scrolling type. Some settings are conveniences rather than necessities, such as standard or reverse video or cursor type. Others are more fundamental, such as baud-rate settings and on-line/local. Some are more useful for certain applications than others: a terminal that can be adjusted to display a full 132-character line as well as a conventional 80-character line is particularly useful with a 132-column line printer. These adjustments can be made semipermanent if the internal microprocessors can deposit the settings in nonvolatile memory.



The VT-50 series terminal, *an advance over DEC's earlier VT-05, featured upper- and lower-case letters, an auxiliary keypad for entry of numeric or special control characters (as for word processing), scroll control and provisions for extra features. The VT-50 series was cooled by air convection.*

More sophisticated features are available for other user requirements. Floppy disk storage allows extensive local editing of text or programs. If a user needs local as well as host-based computer capabilities, a terminal that doubles as a personal computer fills the bill.

The modularity of many modern terminals *extends to the capability to convert to personal computers. The VT-18X option converts the VT-100 terminal to a CP/M-based personal computer. The option can be installed in the field.*

A terminal should provide hardware and software compatibility with the computer to which it is linked. This requirement can usually be met by considering only terminals that conform to industry standards, such as EIA interfacing, ASCII-character encoding and ANSI software-command sequences. A nonstandard video terminal can require both hardware and software alterations in the system. A nonstandard terminal's method of positioning cursors, erasing characters or highlighting, for example, might be incompatible with the host's command set. The terminal might "almost" work: it would be acceptable for alphanumeric characters, but not control commands. Adaptation could be a time-consuming and expensive process.

A manufacturer might have a nonstandard terminal so attractively priced that it makes economic sense to adapt the system to the terminal or the terminal to the system. If a user modifies the system, however, he may be unable to second-source the terminals.

Features

A purchaser should determine which of the many available advanced features are cost-effective for his application in addition to the basic capabilities of a terminal. These features range from user conveniences to add-on boards for more powerful functions.

Terminal cost, including purchase price and maintenance over the life of the product, should be weighed against the degree of productivity the terminal pro-

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CIRCLE NO. 175 ON INQUIRY CARD

LANG SYSTEMS, INC.

vides an operator. A low-cost terminal that is easily repaired might not be as easy to use as a moderately priced terminal with advanced features. The resulting lower operator productivity is a cost like any other. Human engineering, or ergonomics, provides a means of reducing fatigue, which in turn increases operator productivity. Ergonomic considerations include the adjustability of the terminal's position and the display characteristics. Some terminals have built-in capabilities for tilting and swiveling the screen, while others are available with stands that adjust. Detached keyboards are also effective for achieving a comfortable position.

Because not every environment needs an anti-glare device, providing one as an option is a cost-effective compromise.

The display should be easy to read, with a minimum 7 × 9 dot matrix for each character. The font should also be readable: letters such as "j," "g" and "q" are far more recognizable with below-line descenders than without.

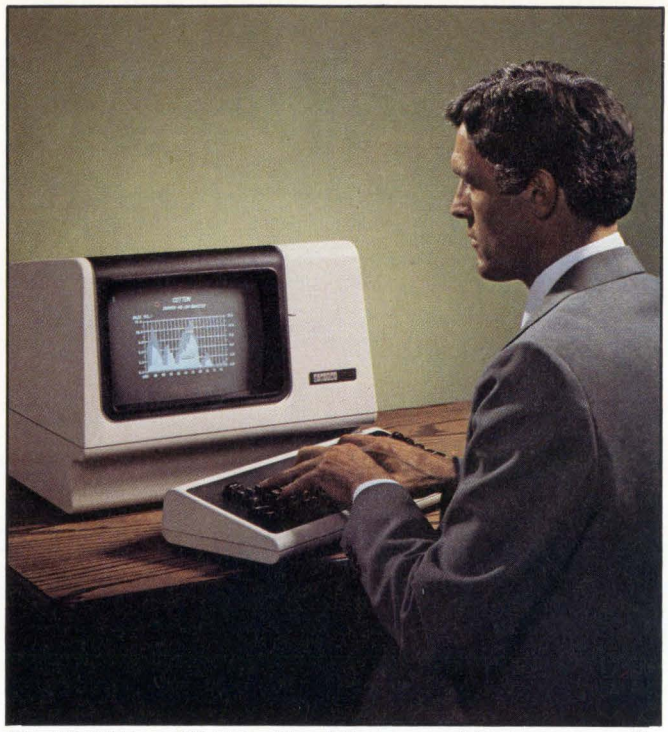
Displays generally provide light characters on dark backgrounds, but many terminals also offer "reverse video," or dark characters on a light background.

Different terminals employ CRTs with different phosphors. The most common phosphor glows bluish-white, like a black-and-white television screen, but many terminals use a green phosphor, that most operators find easier on the eyes. Another phosphor variable is persistence, the amount of time it takes an image to fade after it has been "written" on the screen. A low-persistence phosphor can seem somewhat "flickery" if a screen is filled with data, whereas a high-persistence phosphor can cause characters to smear when moved, particularly if the terminal uses smooth scrolling. For most applications, a medium-persistence phosphor is preferred.

An anti-glare provision is needed in environments with harsh ambient-lighting conditions. An optical filter, built onto the CRT's surface or attachable in front of the CRT, can often significantly cut glare. Because not every environment needs an anti-glare device, providing one as an option is a cost-effective compromise.

The keyboard should have a standard "qwerty" typewriter layout because nearly everyone that types is used to this arrangement. A sculptured keyboard, in which the keys are shaped to reflect their row position on the keyboard, is also desirable for touch typists.

Specialized keys should be grouped in a keypad, where they will not interfere with the basic alphanumeric keyboard. Numeric keypads are important for rapid entry of numeric data in commercial environments, while specialized applications requiring unique key entries can use the numeric keypad with special keycaps. In word-processing applications, for instance, a keycap marked "upper case" could be used as a numeric-entry "3" in other operations.



The VT-125 is a VT-100 with a bit-map graphics processor. *The graphics processor presents a monochromatic display on the terminal's screen, but has an RGB output for color presentations on slaved color monitors. A VT-100 with the advanced video option can be converted to a VT-125 in the field by a technician. An optional printer port enables users to attach printers with bit-map capabilities to obtain hard-copy graphical presentations.*

The VT-100 series of terminals *incorporates a standard setup feature that enables an operator to set terminal characteristics through keyboard commands. Its detachable keyboard is a common feature today, increasing adaptability to various work environments. VT-100 construction is modular, and options can be incorporated in the monitor cabinet. Pop fasteners provide easy access to all components, enabling quick repairs.*

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Buffered mode	**Yes**	No	No	**Yes**	No	**Yes**	Yes	Yes
Tilt screen	**No**	No	No	**Yes**	No	**Yes**	Yes	Yes
Function keys	**14**	No	10	**14**	3	**22**	22	22
Line graphics	**No**	No	No	**No**	No	**Yes**	No	Yes
Page/line transmit	**Yes**	No	No	**Yes**	No	**Yes**	Yes	Yes
Character/line editing	**Partial**	No	No	**Yes**	No	**Yes**	Yes	Yes
Split screen	**No**	No	No	**No**	Yes	**Yes**	Yes	Yes
Smooth scrolling	**No**	No	No	**No**	No	**Yes**	No	Yes
Price (in quantity of one)	**$595**	$595	$699	**$645**	$645	**$895**	$995	$1,195

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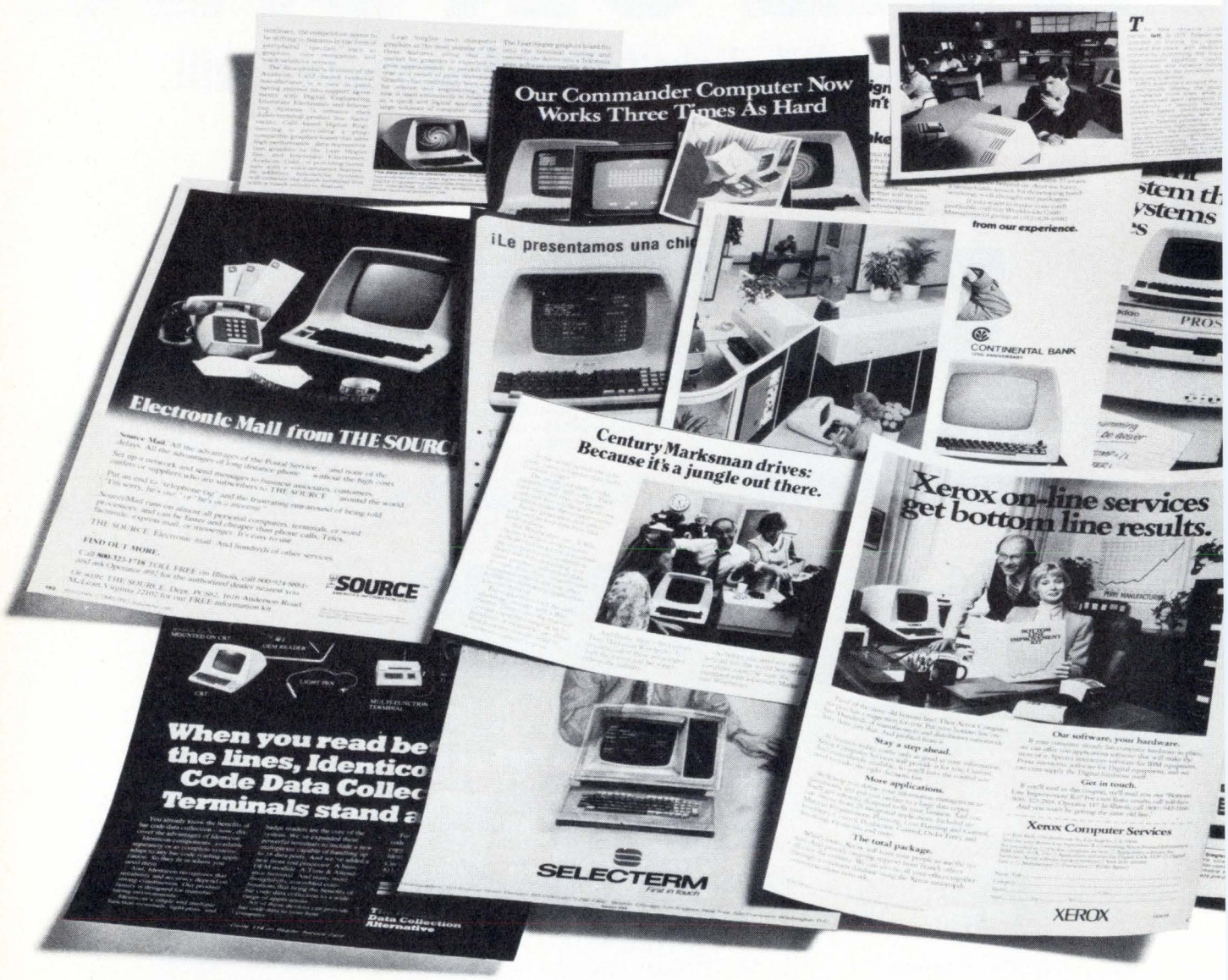
CIRCLE NO. 176 ON INQUIRY CARD

SOME OF OUR BEST A



There's a reason we get so much free advertising in so many ads for so many other companies' products. In so many articles. And in so many movies and TV shows.

It just happens to be very difficult to take a photograph in a computer environment without having a Lear Siegler terminal show up in the shot.

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We're used in more computer-based systems than anyone else. And survey after survey shows we're the world's favorite independent terminal manufacturer.

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CIRCLE NO. 177 ON INQUIRY CARD

More advanced terminal features, such as graphics and local processing capabilities, are now available as add-in boards. Such relatively expensive options are thus available for those applications requiring them without adding to the terminal's cost for those that do not.

Terminals have traditionally been categorized as 'dumb,' 'editing' or 'intelligent,' although these labels vary with the manufacturer and the user.

For example, a computer terminal used in a business system might be more useful later if it could be adapted to display graphs as well as rows and columns of figures. Some terminals accept a microprocessor card that provides a bit-mapped graphics presentation. Such options are generally capable of simple charts, graphs, and histograms rather than complex images. This medium-quality graphics presentation is useful in business and educational applications, but terminals used for engineering design often require a special processor that can draw vector-driven lines. Engineering terminals often have auxiliary input devices, such as joysticks or light pens for cursor placement and user interaction. Unless there is a need for such a terminal's features, it is impractical.

A user requiring local processing should look for a terminal that accepts a circuit card with a general-purpose microprocessor. Such options convert a video terminal to a personal computer on a switch-selectable basis. Terminal buyers were once forced to pick a level of terminal functionality and stick with it. With today's more flexible terminals, their CRTs can grow with their applications.

Reliability and standards

A terminal with a history of low reliability is like a pair of cheap shoes: a user can't afford to buy it.

To help maintenance, some terminals have a self-test feature. When the terminal is on, a microprocessor runs a series of tests on the components, and identifies malfunctioning parts.

A terminal should be modularly organized so that it can be disassembled easily and quickly, and repaired by module swapping.

Whatever the geographic region in which terminals are installed, there should be a convenient means to get quick service. Terminal servicing can include on-site service, depot or shop repair or circuit-board mail-in service. A user might keep spare circuit boards so that the terminal stays up while malfunctioning parts are repaired.

The more complete the documentation that accompanies a terminal, the better. Some terminals have simple operating instructions with a short troubleshooting chart; others have extensive manuals of 50 pages or more that detail the terminals physically, electronically and operationally. Some small and most large manufacturers have extensive facilities for maintenance training. These may be formal classrooms, informal training sessions or videotape presentations. Such training facilities may enable a volume buyer to develop an effective in-house maintenance team.

If a user needs local as well as host-based computer capabilities, a terminal that doubles as a personal computer fills the bill.

A manufacturer with an extensive service organization, particularly a multinational one, can generally provide quick, in-depth support. Third-party support can sometimes involve delays in parts delivery and engineering change orders, but can save money for owners of popular terminals.

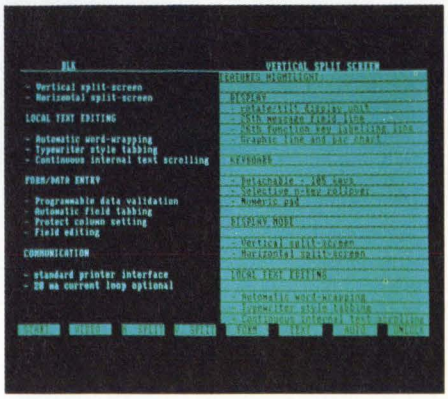
Even a reliable and maintainable terminal can cause problems if it does not meet standards such as those from Underwriters Laboratory and the Federal Communications Commission. The UL standard is safety-oriented and generally is a good indication of sound overall electrical construction. The FCC standards are more application-oriented, but a bargain terminal might prove to be less of a bargain if a user must modify it to stricter FCC criteria than those it was designed to meet.

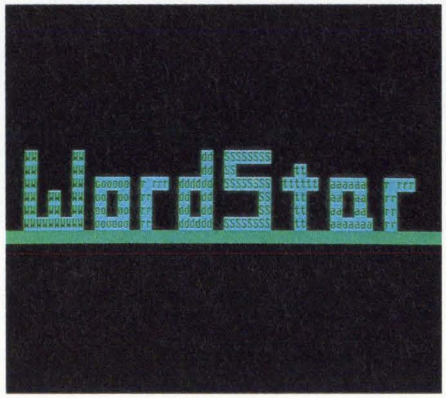
Users who plan to place their systems internationally should check terminals for compliance with all required standards. Terminals might require international character sets to be usable in all the places for which they are targeted: a Briton would not accept "#" for "pound," although an American would not object. Some terminals can adapt to alternate characters through firmware modifications or program control. Terminals used internationally must also be able to handle the line voltages and frequencies of the countries in which they will be used. Some terminals have adjustable power supplies to adapt to local power requirements, while others have modular ones that must be replaced.

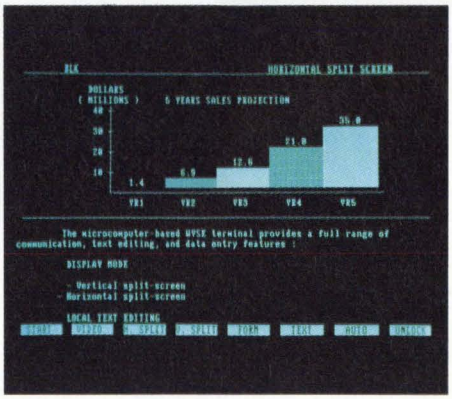
It is generally better to get flexible terminals that will conform to de facto industry and government standards than to get terminals that must be adapted, unless that adaptation can be done economically. □

Lisa Kinneman is a product marketing specialist for Digital Equipment Corp., Maynard, Mass.

A WORD TO THE WISE.







No one gives you more in an ergonomically engineered smart terminal than Wyse.

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You definitely get more from Wyse — the leader in low-cost, high-performance, ergonomically engineered smart terminals.

To begin with, you get a great looking terminal that features die cast aluminum packaging and takes up a minimum of desktop space.

You also get a terminal with an uncanny way of pleasing people. It comes with an easy-on-the-eyes green phosphor screen. And a fully tilting/rotating display and detached keyboard. (After all, one person's just-right-tilt is another's not-quite-right-tilt).

When the workload seems impossible, horizontal and vertical split screen capabilities with independent scrolling allow you to be in two places at once.

There's more. You get programmable function keys and transparent print. Plus 128 characters with upper and lower case, line drawing and graphics, and a keyboard with 105 keys — including cursor pad, special mode and function keys.

Of course, all of this wouldn't mean much if you couldn't count on Wyse quality. That's why each WY-100 is put through an extensive on/off testing program.

On top of that, WordStar® and other emulations are now available from your distributor. Which means you can automatically get 32 of WordStar's most commonly used multi-key commands fully-implemented on our function keys for faster, easier use.

We think you'll be quite impressed when you compare the WY-100 to other terminals in its class. But don't take our word for it. Call or write us today. We'll send you detailed information on why the WY-100 smart terminal gives you more. A lot more.

See us at Comdex, booth #5156.

WYSE TECHNOLOGY

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In the East, call (516) 293-5563.

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Before you buy any the features of

Drawing Solutions on Screen
The 950's powerful graphics capability can express complex data as clear charts, diagrams, graphs, line drawings or other visuals to facilitate communication.

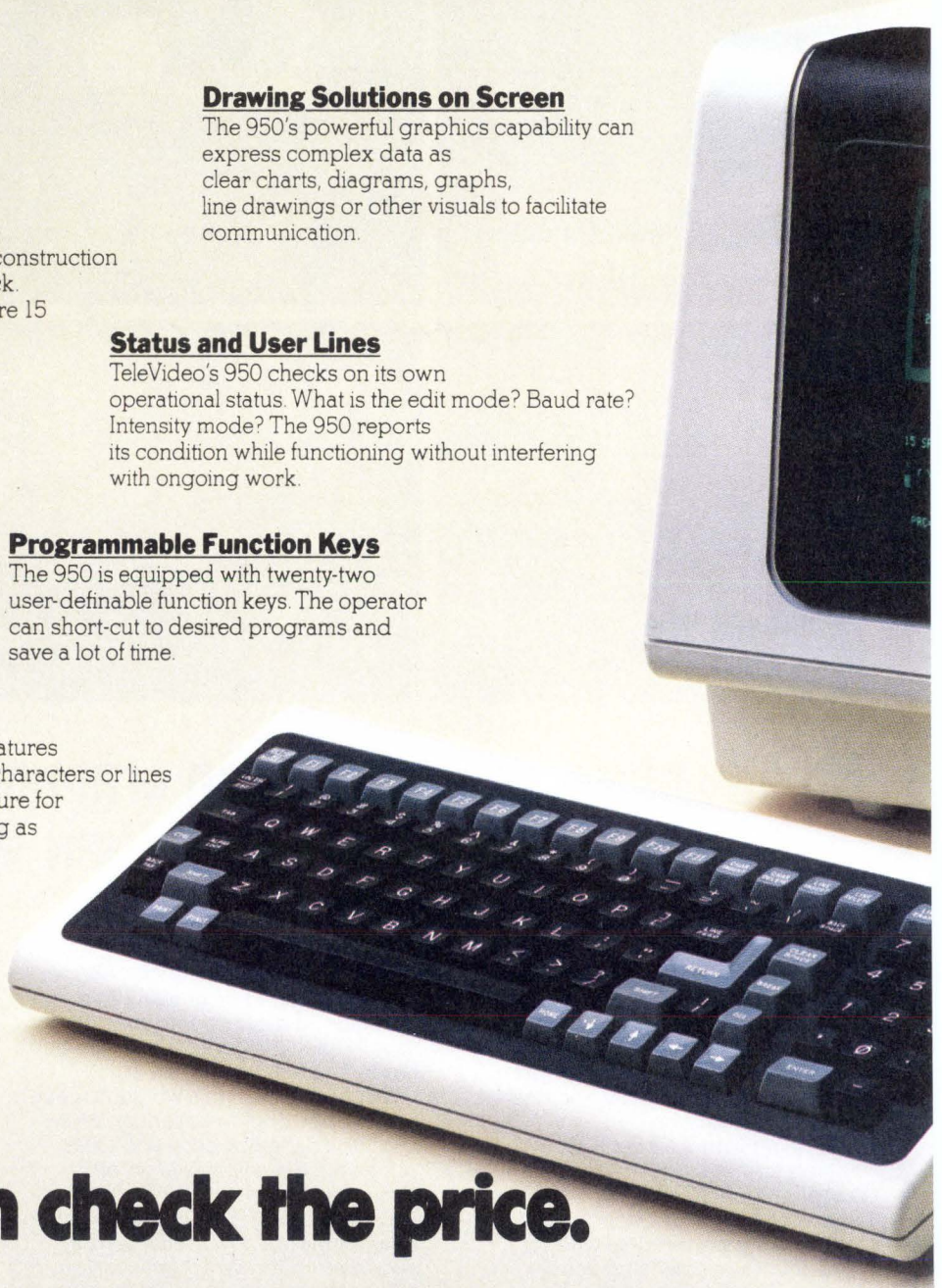
Mean Time to Repair
Our simple design, quality components and modular construction make service easy and quick. Our average MTTR is a mere 15 minutes.

Status and User Lines
TeleVideo's 950 checks on its own operational status. What is the edit mode? Baud rate? Intensity mode? The 950 reports its condition while functioning without interfering with ongoing work.

Programmable Function Keys
The 950 is equipped with twenty-two user-definable function keys. The operator can short-cut to desired programs and save a lot of time.

Editing
TeleVideo's sophisticated editing features let you insert or delete characters or lines with a wraparound feature for maintaining data as long as you need it on screen.

Ergonomic Keyboard
The 950's detachable keyboard is made for operator comfort. Work close to the screen, or place it on your lap. You decide what is more comfortable and productive.



And then check the price.

TeleVideo's 950 offers the features you'd expect in terminals costing much more than ours. And most of these features are also offered in our 925, at even a lower price. Both terminals are built with TeleVideo reliability, both engineered for high performance.

Whichever you choose, you can be assured of the same high quality and reliability, as well as nationwide service by General Electric's Instrumentation and Communication Equipment Centers.

And TeleVideo builds to sales projections, and does not keep you waiting for delivery. That means if you order 200 TeleVideo terminals

California/Santa Ana 714-557-6095; Sunnyvale 408-745-7760; Georgia/Atlanta 404-255-9338; Texas/Dallas 214-980-9978; Illinois/Chicago Area 312-351-9350;

smart terminal, check TeleVideo's 950.

Line Lock
You can frequently reserve data by freezing some facts on screen while changing others. This feature eliminates inadvertent changes of field.

Buffered Print Port
TeleVideo's 950 can be used with printers of various speeds, so you won't lose data during slower peripheral cycles.

Transmission Speed
Our baud range is 50B to 19.2Kb, broad enough to accept data for the great majority of applications.

Smooth Scrolling
The 950, like all TeleVideo terminals, offers easy reading of fast-moving information, without those jerking movements that strain your eyes.

Self-testing
Remote troubleshooting feature determines if a service call is really needed, or if the operator can handle the problem. That saves time and money.

Tilting Screen
Just touch a knob to make the screen tilt toward the viewer. There's no need for neck-craning here. The tilting screen is designed for easy use.

today, we can ship them tomorrow.

To learn more about the 950, the 925 and the other terminals that have made TeleVideo the industry leader, complete this coupon, or call: 800-538-8725 (In California, 408-745-7760).

TeleVideo Systems, Inc.

TeleVideo Systems, Inc.
Attn: Terminal Division
Dept. 216D
1170 Morse Avenue, Sunnyvale, CA 94086

I would like more information about TeleVideo's 950 and 925 terminals.

NAME _____

COMPANY _____ TITLE _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

PHONE # _____

Suggested retail price for TeleVideo's 950, $1195; TeleVideo's 925, $995, excluding applicable state and local taxes — Continental U.S.A., Alaska and Hawaii.

Massachusetts/Boston 617-668-6891; New York/New Jersey 201-267-8805; United Kingdom/Woking, Surrey 44-9905-6464.

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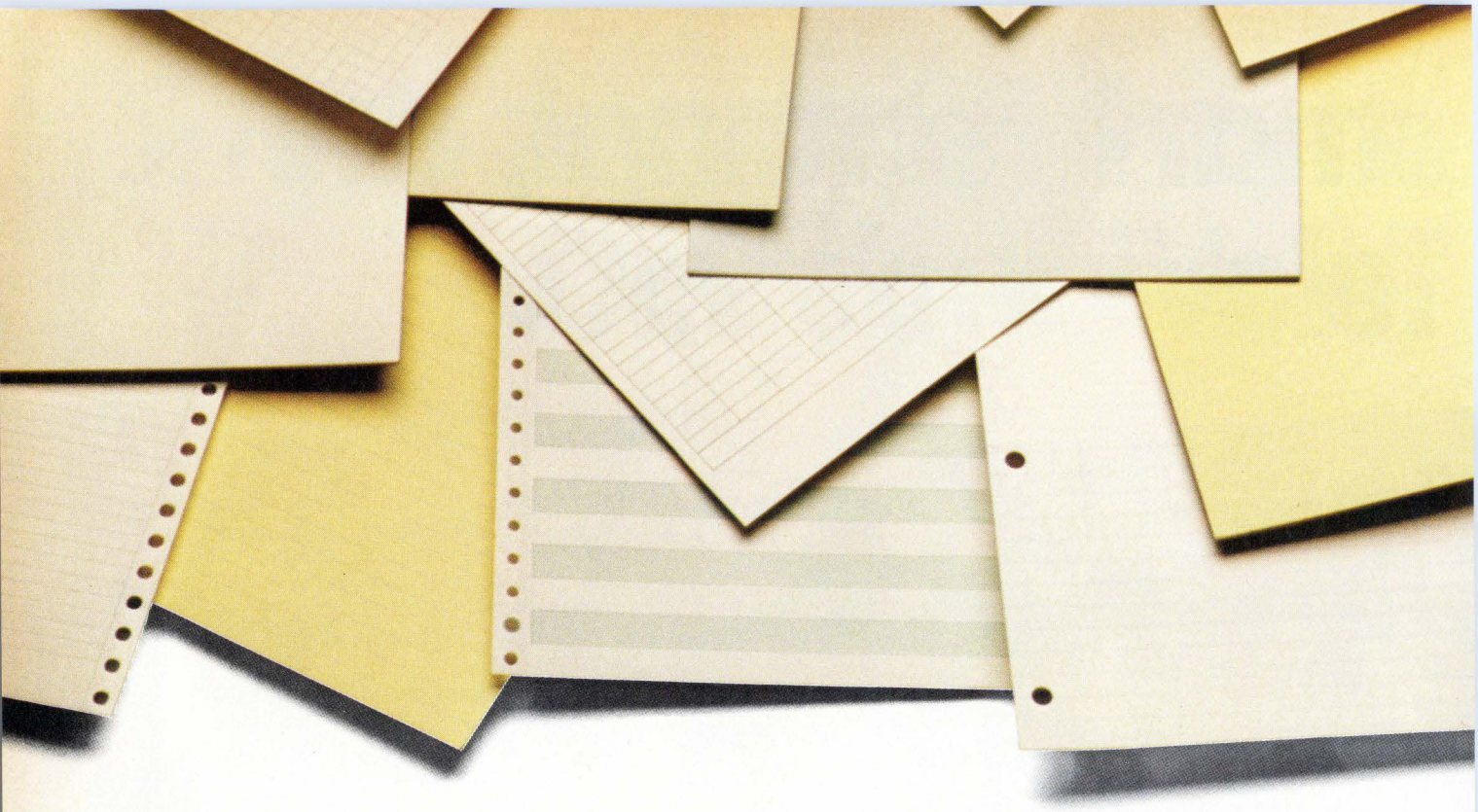
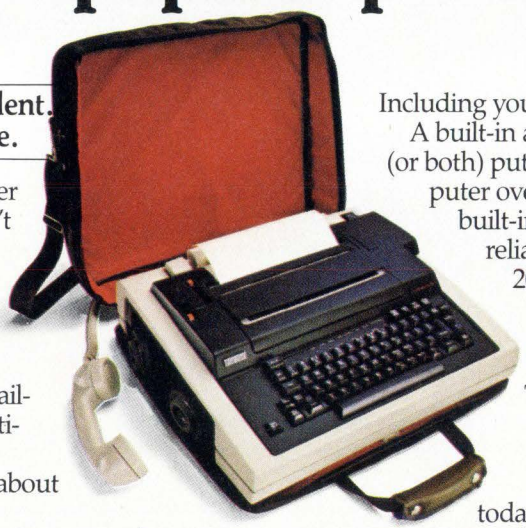


Digital's portable terminal. The only thing plain about it is the paper it prints on.



Introducing the Correspondent. The plain paper portable.

Now there's a portable DECwriter terminal from Digital that doesn't depend on thermal paper to do business.

Virtually any paper will do, so the Correspondent is always ready to go.

Plain paper is inexpensive, available everywhere, usable for multipart forms, and won't fade.

But there's nothing else plain about the Correspondent.

You can't buy a faster portable. It can translate standard-size computer text and graphics onto ordinary 8½" x 11" paper, all in clear, crisp dot-matrix printing. And do it in any of 10 languages.

Including yours.

A built-in acoustic coupler or modem (or both) puts you in touch with your computer over any telephone line. Another built-in: the Digital reputation for reliability and service, backed by 200 carry-in service centers worldwide.

Is the Correspondent the best portable you can buy? That should be plain.

As plain as the paper it prints on.

See your Digital distributor today or call 1-800-DIGITAL, extension 700. In Canada, call 1-800-267-5250. Or write **Digital Equipment Corporation,** Terminals Product Group, 2 Mt. Royal Avenue, UP1-5, Marlboro, MA 01752.

digital

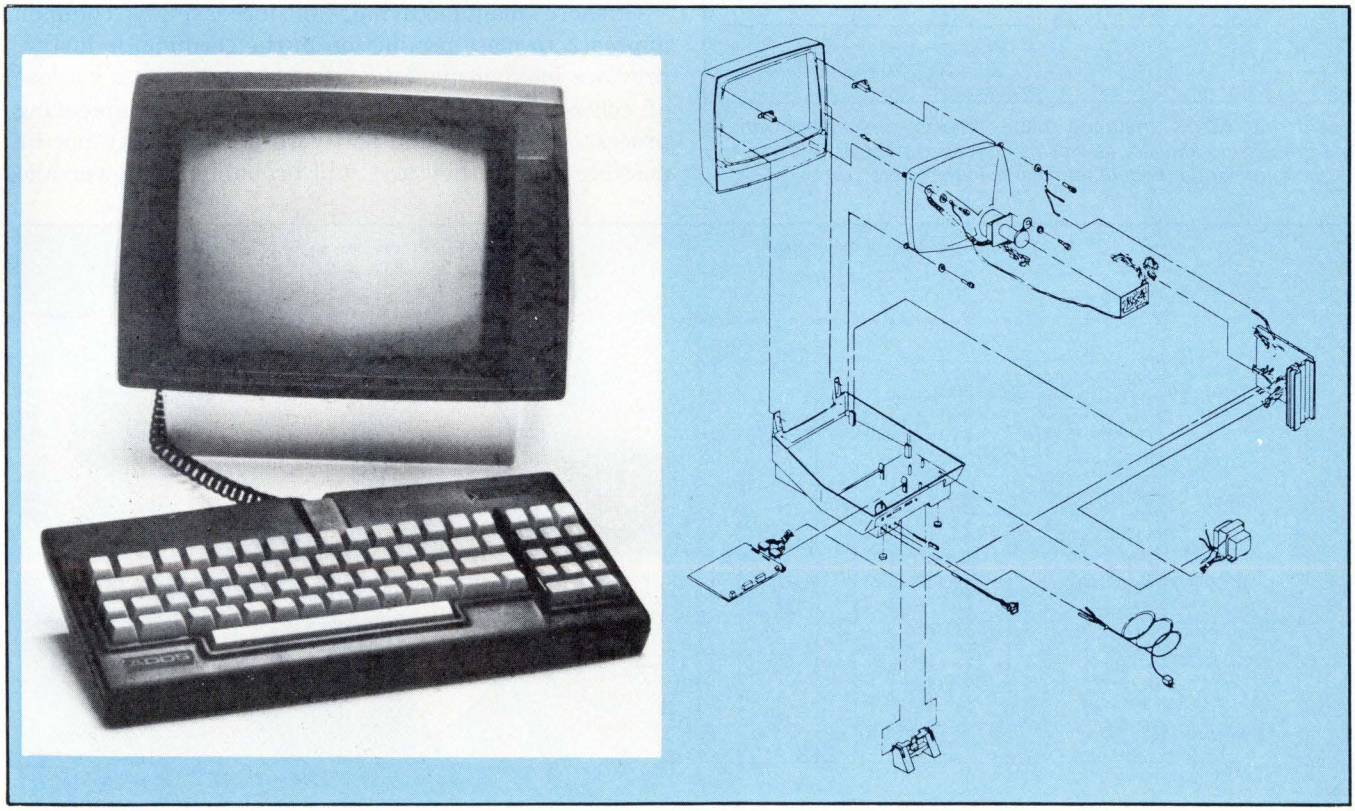
CIRCLE NO. 180 ON INQUIRY CARD

Selecting a low-end display terminal

WILLIAM J. CATACOSINOS and JOHN WITHEROW, Applied Digital Data Systems, Inc.

Terminal buyers should evaluate the manufacturer as carefully as they do the product

As industry competition turns low-end terminals into commodities, purchasers are likely to base their terminal selections on a manufacturer rather than on a product. OEMs, distributors and large end users will each have different criteria in evaluating a low-end terminals manufacturer, and these criteria will proba-



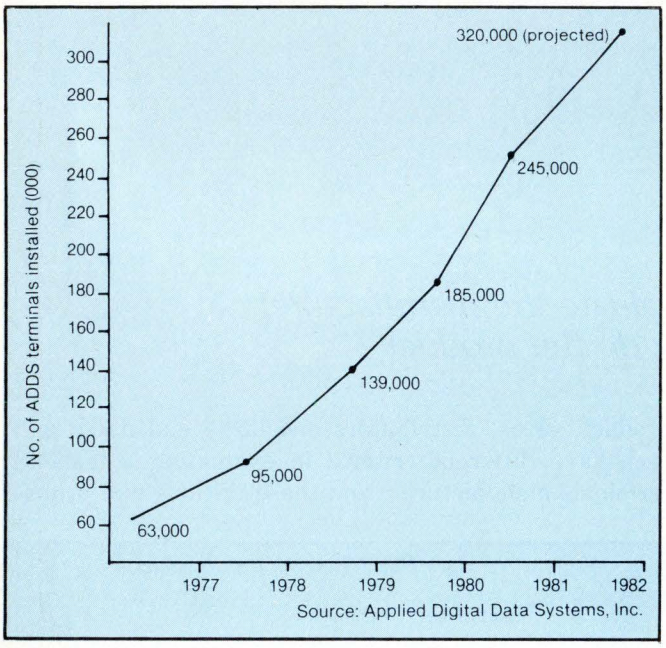
ADDS Viewpoint terminal *is typical of the current crop of low-priced, full-featured terminals. Simple design and low component count help keep price down.*

bly change with the evolving channels of distribution.

OEM requirements

OEMs need a long-term commitment from subsystem manufacturers and should consider a manufacturer's financial stability, experience in the terminal business, installed base and the track record and continuity of its management.

Product quality is also a key issue for OEMs. A terminal is an important part of a product because it is a user's window to a system. The user often considers the terminal to be the system. If the terminal fails, the user believes that the computer has failed. Because the terminal has an OEM's name on it, the OEM's image is on the line. For this reason, the terminal's reliability should be seriously considered.

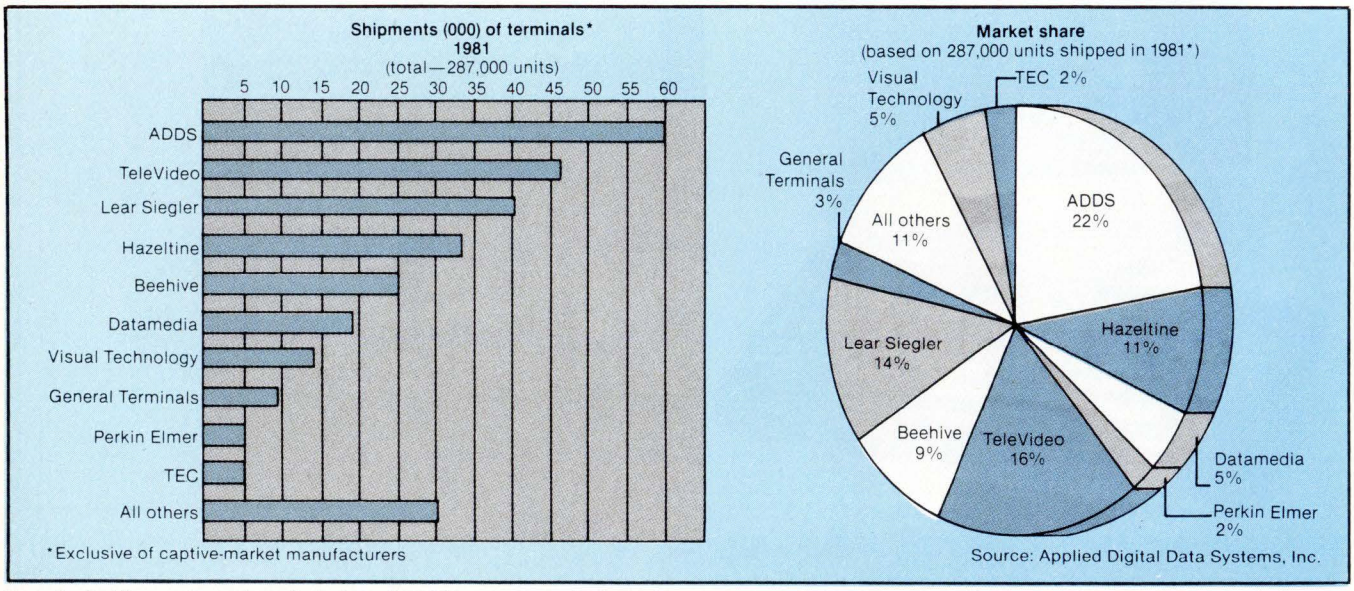


Growth of ADDS installed base *reflects general growth of data-processing industry as well as increased popularity of low-end products from independent terminal manufacturers.*

Applied Digital Data Systems, Inc., achieves a mean time between failure in excess of 23,000 hours for its Viewpoint terminal through a reduction in the number of components and in improvements in keyboard and monitor reliability. The Viewpoint contains 12 components on one circuit board and uses a custom-designed CRT controller chip.

An OEM must also determine a manufacturer's policy on providing spare parts and support. Because the OEM's product is likely to be on the market for at least five years, spare parts and technical support will be required in many cases after the manufacturer has discontinued the terminal. It is also important for an OEM to determine whether the manufacturer is an experienced supplier to OEMs. Large OEMs in particular prefer to buy from large manufacturers that can be contacted directly and from which they can get quick responses when the OEM's needs change. Although many OEMs are engineering-oriented and prefer to do their own customization, more look for a terminal vendor that provides that service. In-house customization is costly for OEMs; additional expense is incurred whenever a terminal's case is opened. Manufacturers are becoming more experienced in this customization, and have in many instances organized well-rounded customization teams that include marketing as well as engineering expertise.

Offshore manufacturing, an increasingly common approach to mass production in the terminal industry, provides inexpensive labor, but typically entails a loss of control over the manufacturing and engineering process. Hardware and software changes may not be possible and, if they are, will probably be slower and



Terminal shipments and market share in 1981 *were largely divided between less than a dozen manufacturers. Most of the terminals shipped were low-end terminals.*

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The ERGO 4000 offers the following additional features:

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ERGO 4000

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The Freedom™ 100

You'll Like Our Numbers.

Now you don't have to pay for those "extras" you find only on the higher-end terminals. That's because – at $595 – the new Freedom™ 100 gives you the first class features you want – but at the economy price you can afford. The Freedom 100 also comes with a complete six-month factory warranty.

If anything goes wrong with the terminal we'll fix it – or send you a replacement unit – within three days of receipt. If we don't, you get $100. Cash. The Freedom 100 is the first in a long line of Freedom Series terminals that put a low price on high performance. Check it out for yourself.

Standard Features	Liberty Freedom™ 100	ADDS Viewpoint	Lear Siegler ADM 21	Hazeltine Esprit	TeleVideo® 925
7 X 9 Dot Matrix	✓			✓	
25th Status Line	✓				✓
Video Attributes By Character	✓		✓		✓
Attributes Req No Display Space	✓	✓		✓	
Line Drawing Character Set	✓				
Screen Tilt	✓	✓			✓
Read Cursor Address	✓		✓	✓	✓
Detachable Keyboard	✓	✓			✓
Separate Function Keys	10	3	1	0	11
Insert/Delete Line Key(s)	✓		✓	✓	✓
Insert/Delete Character Key(s)	✓		✓		✓
Clear EOL/EOP Key(s)	✓		✓		✓
Print Key	✓				✓
Block Mode	✓		✓	✓	✓
Baud Rates to 19.2	✓	✓	✓		✓

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more difficult. Further, product availability is likely to be lower. If an OEM has a product customized, buying from a domestic manufacturer is even more important because terminals can be produced as stock items and drop-shipped, lowering an OEM's inventory requirements.

A manufacturer that provides a family of products is best for an OEM. While an OEM may require only low-end terminals, he might want to upgrade a system. If so, he would want to do so without switching terminal manufacturers. The OEM should also determine whether a manufacturer's products are upwardly compatible, and, if so, provide a migration path and protect a customer's software investments.

If the terminal fails, the user believes that the computer has failed.

Distributor and end-user requirements

Because a distributor's profitability rests on return on assets, the distributor should seek a popular manufacturer and popular equipment that can increase the turnover of his inventory. The distributor should also seek a manufacturer that continues to produce new and attractive state-of-the-art products with high perceived values.

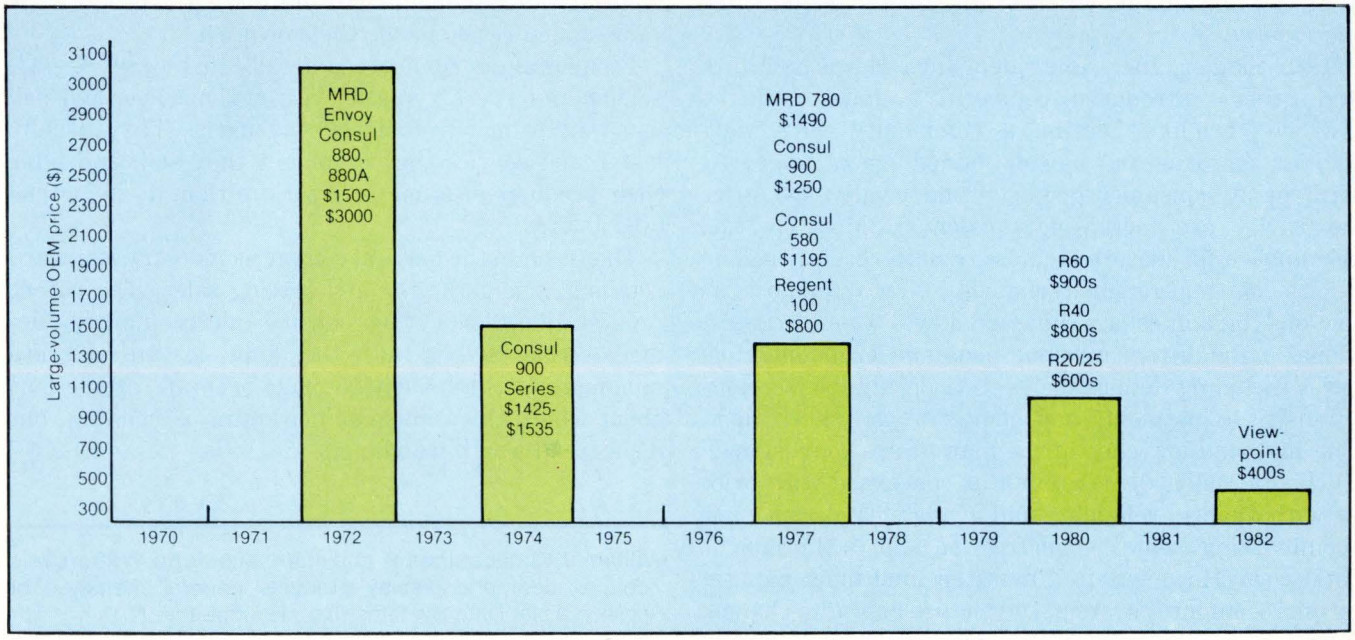
Because a distributor's ability to provide immediate delivery is a major selling point, the distributor needs a manufacturer that can reliably meet the delivery schedule and fill orders promptly if inventory is depleted. Product quality is essential to the distributor's return on assets goal and should be a major consideration in selecting a terminal to distribute.

Economic considerations also figure largely in a distributor's choice of a terminal vendor. Many distributor's profit margins have eroded thanks to today's stagnant economy. The distributor is affected by high interest rates and his need to reduce inventories, coupled with increased competition, has forced distributors to lower prices.

The OEM may want to upgrade his system without switching terminal manufacturers.

The primary concern of a large end user is the availability of service. Because the end user is probably integrating terminals into large multibranch networks, he must know that a vendor can provide appropriate support at all sites. The end user must also consider available service options. ADDS, for example, provides an optional extended warranty program for its Viewpoint terminal (two years for $60 or three years for $90). Without an extended warranty, the subassembly or the entire unit can still be returned to an ADDS service depot for repair, at $65 or $80, respectively. Third-party maintenance contracts are also available for traditional on-site service at $16 per month from either NCR Corp. or TRW, both of which offer an average response time of four hours.

End users, especially large ones that buy several terminals at once, are also concerned with price. They



Downward pricing trend of ADDS terminals *reflects competition in the industry, particularly in the low-end segment.*

may not seek a low price as tenaciously as a high volume distributor would, however. Large end users are often financially stable companies for which component costs represent relatively small expenditures.

Finally, each end user has its own set of terminal selection criteria. A terminal's value to an end user ultimately depends on the unit's ability to meet the application requirements.

Price pressures

The low-end market is not growing as fast as many people think. ADDS disagrees with predictions made over the last few years alleging that the low-end terminal market is growing at 25 to 35 percent per year. These figures are high; ADDS estimates that the market is growing at a maximum of 15 percent a year. Slackening demand and abundant supply from more than 100 vendors have pushed OEM and end-user terminal prices to all-time lows.

More terminals now move through distribution channels with lower marketing expenses.

Two years ago, low-end terminals were synonymous with dumb terminals, and were priced at around $800 to $900 each. ADDS changed the shape of the market in March, 1981, with the introduction of the Viewpoint at an end-user, single-quantity price of $650. This low price was made possible by the development of a low-cost LSI CRT controller (with Standard Micro-Systems) as well as by a mass-market manufacturing approach and a large, vertically integrated manufacturing facility.

Lear Siegler, Inc., TeleVideo, Inc., Hazeltine Corp. and others introduced competitive units, and the low-end terminal became a commodity with well-defined features and a well-defined price range. As with many consumer goods, brand loyalty and price sensitivity are increasingly common. Most low-end terminals offer features that were until recently selling points on mid-range terminals. Now standard on low-end terminals are function keys, 12-in. screens, visual highlighting, numeric pads and ergonomic features including detachable keyboards, tiltable screens, intensity adjustments and choice of phosphor colors. The high and low ends of the market are converging.

Theoretically, OEMs are not as concerned with price as with quality, reliability and availability because one terminal represents a small fraction of an OEM product's total cost. However, in a multiterminal minicomputer or microcomputer system, the picture begins to change. There, a terminal's price is a more significant portion of the system cost, so terminal price can be a buying consideration. A difference of $10 to $20 is not likely to be a major factor to an OEM, whereas to a distributor it is because the distributor's margin is in the terminal alone. Distinctions between pricing requirements for distributors and OEMs are blurring as a result of economic pressures and competition among system integrators. Terminal manufacturers are beginning to feel price pressure from OEMs at a level that was not previously an issue.

The low-end market is not growing as fast as many people think.

Channels of distribution

Five years ago, selling to the OEM, distributor and larger end-user markets was generally accomplished with a large team of manufacturer's sales representatives trained in the technical features of their terminals. Today's low terminal prices prohibit that expensive marketing approach. The direct salesman today sells multi-unit orders and an OEM's or large end user's application. But even this high-level technical sale is becoming a smaller piece of the overall volume. Much more of the volume now moves through channels with lower selling and marketing expenses—the industrial distributor, the peripheral distributor and, more recently, retailing and telemarketing.

A typical industrial distributor, such as Kierulff Electronics or Arrow Electronics, Inc., is a large multi-million-dollar company with large in-house and direct-sales forces offering hundreds of products, generally via casual exposure as opposed to an intensive direct selling campaign. Industrial distributors' customers are about 70 percent computer system OEMs, 15 percent end users and 15 percent traditional industrial OEMs—manufacturers buying a product for value-added resale or for their own use.

Peripheral distributors, generally technically knowledgeable, serve a typically regional market, and sell and rent primarily to large end users. They usually install and service the equipment they sell, and offer their products at a heavier markup than do industrial distributors.

The trend in the general computer industry is toward retailing, telemarketing and catalog sales. The recent proliferation of very inexpensive microcomputers demands that selling cost be kept at an absolute minimum. It is too early to make accurate predictions about where this consumer marketing is heading, but it's a trend worth watching. □

William J. Catacosinos is chairman, and **John Witherow** is vice president and display products general manager, of Applied Digital Data Systems, Inc., Hauppauge, N.Y.

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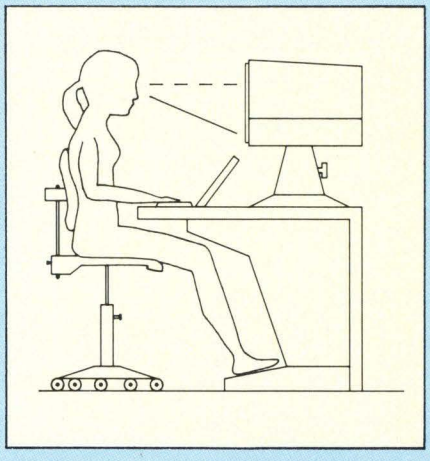
Others talk about ergonomics, TEC can put *true* ergonomics in your office... NOW.

True ergonomics increases job satisfaction, improves office productivity; decreases fatigue induced errors thereby reducing costs where video display terminals are used continuously.

The TEC ET80 includes all internationally known ergonomic standards and recommendations, including the newest and perhaps most important feature in ergonomic design—a Flickerless Positive Display (dark characters on light screen). In fact, results of an independent study show that a Flickerless Positive Display reduces operator errors by 26%!

The TEC ET80 presents an excellent opportunity for quick payback while increasing office productivity.



All the ergonomics/features you need including:

- flickerless positive display (refresh rate well above 60 Hz)
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ALPHANUMERIC TERMINALS

Company Model	Dumb (Y/N)	Editing (Y/N)	Intelligent (Y/N)	Graphics (Y/N)	Portable (Y/N)	Color (Y/N)	Display	Screen format (col. x lines)	Price ($)
AMALGAMATED WIRELESS, LTD.									Did not respond;
AMDEK CORP.									Did not respond;
AMPEX CORP.									
D-30	N	Y	N		N	N	white/green/amber CRT	80 x 25	629, Q100
D-80	N	Y	N		N	N	white/green/amber CRT	80 x 25	729, Q100
D-81	N	Y	N		N	N	white/green/amber CRT	80 x 25	764, Q100
ANASAZI/EMULOG									
Log-200	Y	N	N	N	N	N	12-in. green CRT	80 x 24	1250
ANDERSON JACOBSON, INC.									
AJ 510	N	Y	N	Y	N	N	15-in. green CRT	80 x 24	1995
AJ 520	N	Y	N	Y	N	N	15-in. green/amber CRT	80/132 x 24	2395
ANDROMEDA SYSTEMS									
EDT II	N	Y	N	Y	N	N	12-in. B&W CRT	80 x 24	1700
ANN ARBOR TERMINALS, INC.									
Ambassador	N	Y	N	N	N	N	15-in. green CRT	80 x 18/60	1595
Genie	N	Y	N	N	N	N	15-in. B&W CRT	80 x 18/30	1195
Genie 100	N	Y	N	N	N	N	15-in. B&W CRT	80 x 18/30	1395
APPLIED DIGITAL DATA SYSTEMS, INC.									
Viewpoint	Y	N	N	N	N	Y	12-in. gray/green CRT	80 x 24	650
Viewpoint/3A Plus	Y	N	N	N	N	Y	12-in. gray/green CRT	80 x 24	650
Viewpoint/60	N	Y	N	Y	N		12-in. gray/green CRT	80 x 25	895
Viewpoint/90	N	Y	N	Y	N		12-in. gray/green CRT	80 x 25	895
ARTEL CORP.									Did not respond;
ARTS COMPUTER PRODUCTS									
Large Print Terminal	N	N	Y	N	N	Y	19-in. 8-color CRT		
AXLON, INC.									Did not respond;
AYDIN CONTROLS									
5217CT	N	N	Y	Y	N	Y	13-/19-/25-in. 8-color CRT	80 x 48	4795
AZURDATA, INC.									
Scorepad	N	Y	N	N	Y	N	red LED	24 x 1	1850
Scorepak	Y	N	N	N	Y	N	red LED	14 x 1	300
BEEHIVE INTERNATIONAL									
DM5	N	Y	N	Y	N	N	12-in. green CRT	80 x 25	880
DM5A	N	Y	N	N	N	N	12-in. green CRT	80 x 25	1095
DM5B	N	Y	N	N	N	N	12-in. green CRT	80 x 25	1295
DM310	N	Y	N	N	N	N	12-in. green CRT	80 x 25	1295
DM78	N	Y	N	N	N	N	12-in. green CRT	80 x 25	1495
DM83	N	Y	N	N	N	N	12-in. green CRT	80 x 25	1995
BMC USA, INC.									Did not respond;

Interfaces	Specify fonts	Special features
see directory for address		
see directory for address		
		detached kbd., up/flip scroll, 20 PF keys
RS232C 20mA loop, printer port		Data General 2-200 emulation, detached keyboards
RS232C	ASCII, APL, graphics	2K memory, inverse video, underline, blink
RS232C	ASCII, APL, graphics	21K memory, YT100-compatible, 4 setup menus, double wide/high
DEC LSI-11 Q-Bus		Teletronics 40-10 graphics capabilities, others
RS232 standard; 20mA, RS449 optional		60 lines, programmable keys, 3 types of print
RS232 standard 20mA, RS449 optional		30-line memory with scrolling, programmable keys
RS232 standard 20mA, RS449 optional		60-line memory, programmable keys
RS232	6 foreign	tilts
RS232	6 foreign	emulates Lear Siegler ADM 3A, tilts
RS232, current loop, RS422 optional	6 foreign	function keys, emulates ADDS Regent 40 & 60, tilts
RS232 standard, current loop, RS422 optional	6 foreign	programmable function keys, flexible and reconfigurable, others
see directory for address		
RS232	3 fonts, 4 sizes each	temporary memory stores host and user transmissions for review
see directory for address		
RS232	256 characters	CP/M, diskette drives optional
RS232, Async, Modem, Bisync	128 ASCII	
RS232, Async, Modem, Bisync		bar code scanning
RS232	ASCII, foreign	time of day clock, cursor pad, tab
RS232, 20mA loop	ASCII, foreign	time of day clock, cursor pad, tab, PF keys, numeric pad
RS232, RS442, 20mA loop	ASCII, foreign	time of day clock, cursor pad, tab, PF keys, numeric pad
	ASCII	emulates IBM 3101, cursor control, self test
RS232, RS442, 20mA loop	ASCII	emulates IBM 3278, cursor addressing, self test
TDI, RS232	ASCII	emulates Burroughs TD830
see directory for address		

ALPHANUMERIC TERMINALS

Company Model	Dumb (Y/N)	Editing (Y/N)	Intelligent (Y/N)	Graphics (Y/N)	Portable (Y/N)	Color (Y/N)	Display	Screen format (col. x lines)	Price ($)
BURR-BROWN RESEARCH CORP.									
TM25	Y	N	N	N	Y	N	LED	8 x 1	249
TM27	Y	N	N	N	Y	N	LED	8 x 1	250
TM70	Y	N	N	N	Y	N	LED	12 x 1	450
TM71	Y	N	N	N	Y	N	LED	16 x 1	595
TM71B	Y	N	N	N	Y	N	LED	16 x 1	1495
TM77	Y	N	N	N	Y	N	LED	16 x 1	595
TM77B	Y	N	N	N	Y	N	LED	16 x 1	1495
BURROUGHS CORP.									Did not respond;
C. ITOH ELECTRONICS, INC.									
CIT-101	N	N	N	Y	N	N	12-in. B&W/green/amber CRT	80/132 x 12/24	1695
CIT-161	N	N	N	Y	N	N	12-in. B&W/green/amber CRT	80/32 x 12/24	2700
CIT-414	N	N	N	Y	N	N	12-in. green CRT		1995
CIT-427	N	Y	N	Y	N	Y	12-in. 8-color CRT		3600
CIT-80	N	N	N	Y	N	N	12-in. B&W CRT	80 x 24	1145
CALCOMP, INC.									Did not respond;
CARTERFONE COMMUNICATIONS CORP.									
7276	N	N	Y	N	N	N	12-in. B&W CRT	80 x 24	2995
7700	N	Y	N	N	N	N	12-in. green CRT	64 x 23	6800
7800 series	N	Y	N	Y	N	N	12-in. B&W CRT	80 x 24	2280
9830	N	Y	N	N	N	N	12-in. green CRT	80/40 x 24/12	1795
CIFER SYSTEMS, LTD.									Did not respond;
COBAR, INC.									
3100	N	Y	N	Y	N	N	12-in. B&W/green CRT	80/132 x 25	1395
3132	N	Y	N	Y	N	N	15-in. amber CRT	80/132 x 25	1595
CODEX CORP.									
CDX-268/1	N	Y	N	Y	N	N	15-in. green CRT	80 x 25	1995
CDX-268/2	N	Y	N	Y	N	N	15-in. green CRT	80 x 25	1895
CDX-268/3	N	Y	N	Y	N	N	15-in. green CRT	80 x 25	1995
COLORGRAPHIC COMMUNICATIONS CORP.									
MVI-7	N	N	Y	Y	N	Y	13-in. 8-color CRT	80 x 24	3500
VI-100	N	N	Y	Y	N	Y	13-in. 8-color CRT	80 x 24	2750
COLUMBIA DATA PRODUCTS, INC.									Did not respond;
COMARK CORP.									
MB285	N	N	Y	Y	N	N	12-in. B&W CRT	80 x 24	8585
MB85	N	N	Y	N	N	N	12-in. white	80 x 24	7585
MB85I	N	N	Y	N	N	N	12-in. B&W CRT	80 x 24	5195
MB86I	N	N	Y	N	N	N	12-in. B&W CRT	80 x 24	6795
COMMUNICATIONS AND SPECIAL SOFTWARE									Did not respond;
COMPUTEK, INC.									
Display 8/15	N	Y	N	Y	N	N	12-in. CRT	80 x 25	1560 (OEM)

Interfaces	Specify fonts	Special features
RS232C, 20mA current loop		sealed, tactile-feel keyboard, function keys
RS422		sealed, tactile-feel keyboard, polled operation, function keys
RS232C, 20mA current loop		sealed, tactile-feel keyboard, polled operation, function keys
RS232C, 20mA current loop, RS422		sealed keyboard, polled operation, function keys
RS232C, RS422		integral bar code wand, 5 switch-selectable bar codes
RS232C, 20mA current loop, RS422		sealed numeric keyboard, polled operation, function keys
RS232C, RS422		integral bar code wand, 5 switch-selectable bar codes
see directory for address		
RS232C, aux. 20mA current loop	96 ASCII, 128 alternate	
RS232C (dual), 20mA current loop	96 ASCII, 128 alternate	
RS232		graphics only
RS232		graphics only
RS232 20mA current loop	96 ASCII	
see directory for address		
EIA RS232		IBM 3270 BSC/SNA-compatible
EIA RS232		communicates concurrently with TWX, DDD, TLX, PTL
EIA RS232		supports 83B3, 8A1, 85A, or X-On, X-Off protocols
EIA RS232 and TDI		Burroughs TD 830-compatible
see directory for address		
DEC		printer, programmable function keys
DEC		
RS232	128 ASCII set with European, others	detached keyboard, 12 function keys, editing keypad, setup function
RS422	128 ASCII set with European, others	detached keyboard, 12 function keys, editing keypad, setup function
coax	128-character set with European, others	detached keyboard, 12 function keys, editing keypad, setup function
RS232, RS422, current loop	128 ASCII, 1280 programmable, 384 expansion	horizontal/vertical scrolling, split screen, 2-page memory
RS232	128 ASCII, 256 expansion ROM	horizontal/vertical scrolling, split screen, 2-page memory
see directory for address		
Centronics, floppy		8085 CPU, 64K-byte memory, dual floppies, CP/M software
Centronics, diskette		8085 CPU, 64K-byte memory, dual floppies, CP/M software
		8085 CPU, 64K-byte memory, keylock
		8086 CPU, 128K-byte memory, keylock
see directory for address		
dual RS232C	128 characters	video attributes, 96-key keyboard

ALPHANUMERIC TERMINALS

Company Model	Dumb (Y/N)	Editing (Y/N)	Intelligent (Y/N)	Graphics (Y/N)	Portable (Y/N)	Color (Y/N)	Display	Screen format (col. x lines)	Price ($)
Display 8/25	N	N	Y	Y	N	N	12-in. CRT	80 x 25	3475 (OEM)
Display 8/35	N	N	Y	Y	N	N	12-in. CRT	80 x 25	4975 (OEM)
COMPUTER HORIZONS									Did not respond;
COMPUTER OPERATIONS									Did not respond;
COMPUTER OPTICS									Did not respond;
COMPUTER SYSTEMS CONSULTANTS, INC.									Did not respond;
COMPUTER TALK, INC.									
425	N	Y	N	N	N	Y	12-in. 2-8 color CRT	64/128 x 20	9650
427	N	Y	N	N	N	N	12-in. B&W CRT	64/128 x 20	3136
427ECP	N	N	Y	N	N	N	12-in. B&W CRT	64/128 x 20	14500
COMPUTERWISE, INC.									
TT1	Y	N	N	N	Y	N	B&W LCD	32 x 2	380, Q100
TT2	Y	N	N	N	Y	N	B&W LCD	80 x 1	459, Q100
COMTERM, LTD.									Did not respond;
CONTROL CONCEPTS CORP.									Did not respond;
CPU COMPUTERS, LTD.									Did not respond;
CROMEMCO, INC.									
C-1/CTI	Y	N	N	Y	N	N	12-in. green CRT	80 x 25	695
CYBERNEX, LTD.									
MDL-150	N	Y	N	Y	N	N	12-in. B&W CRT	80 x 25	
XL-87	N	Y	N	N	N	N	12-in. B&W CRT	80 x 25	
DACOLL ENGINEERING SERVICES LTD.									
M248	N	Y	N	Y	N	N	12/15-in. green CRT	80/132 x 25	1367
M262	N	Y	N	Y	N	N	12/15-in. green CRT	80/132 x 25	1032
DATA GENERAL CORP.									
280C	Y	N	N	N	N	Y	13-in. CRT	80 x 24	3750
6110APL	Y	N	N	N	N	N	12-in. B&W CRT	80 x 24	2700
D200	Y	N	N	N	N	N	12-in. B&W CRT	80 x 24	1950
D400	N	Y	N	N	N	N	12-in. green CRT	80/135 x 24	2300
D450	N	Y	N	Y	N	N	12-in. green CRT	80/135 x 24	2800
DATA TYPE, INC.									
Autograph 110	N	Y	N	Y	N	N	12-in. green CRT	80 x 24	1795
Autograph 120	N	Y	N	Y	N	N	12-in. green CRT	80 x 24	1995
Autograph 125	N	Y	N	Y	N	N	12-in. green CRT	80 x 25	2195
Autograph 150	N	Y	N	Y	N	N	12-in. green CRT	80 x 25	2395
Autograph X5A	N	Y	N	Y	N	Y	14-in. 16-color CRT	132 x 34	4995
Autograph XKI	N	Y	N	Y	N	N	15-in. green CRT	132 x 34	4495
DATAMEDIA CORP.									
XL 22/24	Y	N	N	N	N	N	12/14-in. white/green/amber CRT	80/132 x 24	1495
XL 62/64	N	Y	N	N	N	N	12/14-in. white/green/amber CRT	80/132 x 24	1895

Interfaces	Specify fonts	Special features
2-6 RS232C standard; RS449 optional	128 characters standard, 256-640 optional	2X 800K-byte 5¼-in. floppy drives
2-6 RS232C, RS449 port optional	128 characters standard, 256-640 optional	64K-byte RAM, 800K-byte 5¼-in. floppy drives
see directory for address		
see directory for address		
see directory for address		
see directory for address		
RS232, IEEE 488	ASCII	video graphics; each additional color: $2000
RS232, IEEE 488	ASCII	video graphics optional
RS232, IEEE 488	ASCII	video graphics optional
RS232	U/L case	
RS232	U/L case	24-line buffer
see directory for address		
see directory for address		
see directory for address		
S-100, serial	American, bold, scientific	CKBA keyboard optional
	96 characters	detached KBD, numeric pad, Hazeltine emulator optional
V24, 20mA		9 screen attributes
V24, 20mA		
RS170 output; RS232C, 20mA	same as D400	
RS232C, 20mA	APL graphics, 96ASCII	
RS232C, 20mA	U.S., U.K., Danish/Norwegian, French, German	
RS232C, 20mA	same as D200	24 windows, horizontal scrolling, multilingual, special characters
RS232C, 20mA	same as D200	same as D400
RS232C 20mA loop	128 ASCII, English, French, German	emulations: TeleVideo 910, Teletronix 4010
RS232C 20mA loop	96 ASCII, English, French	emulations: TeleVideo 920, Teletronix 4010
RS232C 20mA loop	128 ASCII, English, French, German	emulations: TeleVideo 925, Teletronix 4010
RS232C 20mA loop	128 ASCII, English, alternate program	emulations: TeleVideo 950, Teletronix 4010
RS232C 20mA loop	128 ASCII	emulations: TeleVideo 925, Teletronix 4014/4027
RS232C 20mA loop	128 ASCII	emulations: TeleVideo 925, Teletronix 4014
RS232, 20mA loop	ASCII, business graphics	detached keyboard, DEC VT-100-compatible
RS232, 20mA loop	ASCII, business graphics	detached keyboard, DEC VT-132-compatible

ALPHANUMERIC TERMINALS

Company Model	Dumb (Y/N)	Editing (Y/N)	Intelligent (Y/N)	Graphics (Y/N)	Portable (Y/N)	Color (Y/N)	Display	Screen format (col. x lines)	Price ($)
XL 32/34	Y	N	N	N	N	N	12/14-in. white/green/amber CRT	80/132 x 24	1395
XL 72/74D	Y	N	N	N	N	N	12/14-in. white/green/amber CRT	80/132 x 24	1395
XL 42/44	N	Y	N	N	N	N	12/14-in. white/green/amber CRT	80 x 24	995
ColorScan 10	Y	N	N	Y	N	Y	12-in. 8-color CRT	80/132 x 24	3195
ColorScan 30	Y	N	N	Y	N	Y	12-in. 8-color CRT	80/132 x 24	3195
ColorScan 60	N	Y	N	Y	N	Y	12-in. 8-color CRT	80/132 x 24	3395
ColorScan 70D	Y	N	N	Y	N	Y	12-in. 8-color CRT	80/132 x 24	3195
XL 3270-S	N	Y	N	N	N	N	14-in. green CRT	80 x 24	2295
XL3270-6	N	Y	N	N	N	N	14-in. green CRT	80 x 24	2895
XL3270-8	Y	N	N	N	N	N	14-in. green CRT	80 x 24	1995
DATAVUE CORP.									Did not respond;
DECISION DATA COMPUTER CORP.									
3751-11	N	Y	N	N	N	N	15-in. green/gray CRT	80 x 24	2100
DELTA DATA SYSTEMS CORP.									
2201	N	Y	N	N	N	N	12-in. green CRT	80 x 28	2500
2830II	N	Y	N	N	N	N	12-in. green CRT	80 x 28	2150
7303	N	N	Y	N	N	N	15-in. green CRT	80 x 28	4855
DIGITAL EQUIPMENT CORP.									
VT-100	Y	N	N	Y	N	N	12-in. B&W CRT	132 x 24	1945
VT-101	Y	N	N	N	N	N	12-in. B&W CRT	132 x 24	1350
VT-102	Y	N	N	N	N	N	12-in. B&W CRT	132 x 24	1945
VT-131	N	Y	N	N	N	N	12-in. B&W CRT	132 x 24	1985
VT-125	Y	N	N	Y	N	N	12-in. B&W CRT	132 x 24	3800
RT-100	Y	N	N	N	N	N	12-in. B&W CRT	132 x 24	3900
RT-102	Y	N	N	N	N	N	12-in. B&W CRT	132 x 24	4000
RT-137	Y	N	N	N	N	N	12-in. B&W CRT	132 x 24	5300
DENTRONIX SYSTEMS, INC.									
200	N	Y	N	N	N	N	12/15-in. B&W/green/amber CRT	80 x 25	1450
400	N	N	Y	Y	N	N	12/15-in. B&W/green/amber CRT	81/135 x 25	1650
DIRECT INC.									
825	N	Y	Y	Y	Y	N	12-in. B&W/green CRT	80/132 x 24	1890
828/1	N	N	Y	Y	Y	N	12-in. B&W/green CRT	80/132 x 24/28	2790
831	N	Y	N	Y	Y	N	12-in. B&W/green CRT	80/132 x 24/28	1395
DMC CORP.									Did not respond;
DTI DATA TERMINALS CORP.									
DEC Editor	N	Y	N	Y	N	N	12-in. green/B&W CRT	80/132 x 24	895
DG Editor	N	Y	N	Y	N	N	12-in. green/B&W CRT	80/132 x 24	895

Interfaces	Specify fonts	Special features
RS232, 20mA loop	ASCII, business graphics	detached keyboard, multi-emulation mode
RS232, 20mA loop	ASCII, business graphics	detached keyboad, DG 6053, DG Dasher emulation
RS232, 20mA loop	ASCII, business graphics	detached keyboard, 2-page memory, 8 PF keys
RS232, 20mA loop, Tektronix Plot 10-compatible	ASCII, business graphics	detached keyboard, DEC VT-100-compatible
RS232, 20mA loop, Tektronix Plot 10-compatible	ASCII, business graphics	detached keyboard, extended graphics character set
RS232, 20mA loop, Tektronix Plot 10-compatible	ASCII, business graphics	DEC VT-132-compatible
RS232, 20mA loop, Tektronix Plot 10-compatible	ASCII, business graphics	DG 6053, DG Dasher 100/200-compatible
RS232	EBCDIC, ASCII	IBM 3275-2 and IBM 3276-2-compatible
RS232	EBCDIC, ASCII	IBM 3276-2-compatible, supports 3 slaves
RS232	EBCDIC, ASCII	IBM 3278-2-compatible
see directory for address		
IBM S/34, S/38 Twinax	188-character multinational set	detachable keyboard, palmrest
CCITT V24, RS232	ASCII	text processing, split screen, to 40K-bytes memory
RS232	ASCII	Burroughs emulation
RS232	ASCII	advanced text processing
RS232	96 ASCII	
RS232	96 ASCII	
RS232	96 ASCII	printer port, advanced video option
RS232	96 ASCII	local editing with block transmission mode
RS232	96 ASCII	bit-mapped graphics, printer port
RS232	96 ASCII	
RS232	96 ASCII	
RS232	96 ASCII	bar code reader
RS232 or current loop (DG)	US, foreign, custom	Data General D200 replacement
RS232 or current loop (DG)	US, foreign, custom	Data General D400/450 replacement
1 bidirectional buffered RS232	128 ASCII, graphics	runs HP block-mode software, screen-labeled PF keys, others
2 bidirectional buffered RS232 ports	128 ASCII, graphics, others	runs both HP & DEC software, 32K display memory
2 bidirectional buffered RS232 ports	128 ASCII, graphics	runs DEC block mode, 16K-byte memory
see directory for address		
RS232C, 20mA		local conversational, line spy modes, function keys
RS232C, 20mA		local conversational, page, line, spy modes, function keys, buffer

ALPHANUMERIC TERMINALS

Company Model	Dumb (Y/N)	Editing (Y/N)	Intelligent (Y/N)	Graphics (Y/N)	Portable (Y/N)	Color (Y/N)	Display	Screen format (col. x lines)	Price ($)
DTI 200	N	Y	N	N	N	N	12-in. green/B&W CRT	80 x 24	995
DTI 6053	N	Y	N	N	N	N	12-in. green/B&W CRT	80 x 24	995
DTI Basic Four	N	Y	N	N	N	N	12-in. green/B&W CRT	80 x 24	1595
DTI E52	N	Y	N	N	N	N	12-in. green/B&W CRT	80 x 24	825
DTI HZ1510+	N	Y	N	N	N	N	12-in. green/B&W CRT	80 x 24	895
DTI Prism	N	Y	N	N	N	N	12-in. green/white CRT	80 x 24	1295
Entry 81	N	Y	N	N	N	N	12-in. CRT	80 x 24	895
Fals 200	N	Y	N	Y	N	N	12-in. green CRT	80 x 24	995
Genius 300	N	Y	N	N	N	N	12-in. green/B&W CRT	80 x 24	1295
Proterm 80	N	Y	N	Y	N	N	12-in. green/B&W CRT	80/132 x 24	1495
DY-4 SYSTEMS, INC.									
VGT-100	N	Y	N	Y	N	N	15-in. green CRT	80/132 x 16/24	2771
VGT-100H	N	Y	N	Y	N	N	15-in. green CRT	80/132 x 16/24	2966
ECD CORP.									Did not respond;
ECS MICROSYSTEMS									
4000 Series	N	Y	N		N	N	12-in. green CRT	80 x 25	2450-9750
ELBIT USA									Did not respond;
ENVISION									
210	N	Y	N	N	N	Y	13-in. 16-color CRT	80 x 24	3450
220	N	N	Y	Y	N	Y	13-in. 16-color CRT	80 x 24	4950
230	N	N	Y	Y	N	Y	13-in. 16-color CRT	80 x 24	6950
EPIC COMPUTER PRODUCTS									Did not respond;
EXTEL CORP.									Did not respond;
FALCO DATA PRODUCTS, INC.									
TS-1	N	Y	N	Y	N	N	12-in B&W/green/amber CRT	80 x 25	1295
TS-100SP	N	Y	N	Y	N	N	12-in. green/amber CRT	80/254 x 25	1495
TS-132	N	Y	N	Y	N	N	12-in. green/amber CRT	80 x 25	
TS-2	N	Y	N	Y	N	N	12-in. B&W/green/amber CRT	80 x 25	1495
TS-2624	N	Y	N	Y	N	N	12-in. green/amber CRT	80 x 25	1995
TS-42	N	Y	N	Y	N	N	12-in. B&W/green/amber CRT	80 x 25	1795
FUNGUS COMPUTER PRODUCTS, LTD.									Did not respond;
G.R. ELECTRONICS									
PT12	N	Y	N	N	Y	N	2-in. black LED	12 x 1	425
PT8	N	Y	N	N	Y	N	2-in. black LED	8 x 1	395
VDU	N	Y	N	N	Y	N	37-in. black LCD	20 x 2	995
GARYCO DATA SYSTEMS, INC.									Did not respond;
GENERAL DIGITAL CORP.									
Vuepoint	N	N	Y	N	Y	N	10-in. orange or black plasma panel	40 x 12	3500
GENERAL TERMINAL CORP.									Did not respond;
GENISCO TECHNOLOGY CORP.									Did not respond;

Interfaces	Specify fonts	Special features
RS232C, 20mA		detached, local and line spy modes plus conversational
RS232C, 20mA		detached, local and line spy modes plus conversational
RS232C, 20mA		detached, local and line spy modes plus conversational
RS232, 20mA		VT52-compatible, user-defined functions, transparent print
RS232C, 20mA		2-page memory, cursor addressing, format, local, line spy modes
RS232C, 20mA		local and line spy modes, editing, reverse video
RS232C, 20mA		programmable attributes, transparent print, baud rates
RS232C, 20mA		programmable attributes, transparent print, baud rates
RS232C, 20mA		programmable attributes, transparent print, baud rates
RS232C, 20mA		local conversational, page line spy modes, function keys
RS232	APL	
RS232	APL	
see directory for address		
RS232, RS422, Burroughs TDI	ASCII, foreign	IBM, Burroughs, Honeywell, NCR, Univac, ICL, HP, DEC versions available
see directory for address		
RS232	96 ASCII, user-definable	ANSI-compatible, soft keys, multiple display windows
RS232	96 ASCII, user-definable	area fill, Tektronix 4014 compatibility
RS232	96 ASCII	polygon drawing, display list for vector storage
see directory for address		
see directory for address		
2 RS232 ports	French, German, Swedish	setup screen, programmable function keys
2 RS232C ports	French, German, Swedish	DEC VT-100 emulation, programmable function keys, printer port
2 RS232C ports	French, German, Swedish	DEC VT-132 emulation, block mode, printer port
2 RS232C ports	French, German, Swedish	Lear Siegler ADM1, ADM2 emulation, programmable function keys
2 RS232C ports	French, German, Swedish	Hewlett-Packard 2624, setup screen, printer port
2 RS232C ports	French, German, Swedish	Lear Siegler ADM42 emulation, programmable function keys
see directory for address		
20mA, RS232 or dual		300/1200 baud, baud rate on block send modes
20mA, RS232 or dual		128 ASCII codes
20mA, RS232, RS422		128 ASCII codes, 13 selectable band rates to 9600
see directory for address		
RS232	special character sets optional	touch scanner, microprocessor controller, 3-page memory
see directory for address		
see directory for address		

ALPHANUMERIC TERMINALS

Company Model	Dumb (Y/N)	Editing (Y/N)	Intelligent (Y/N)	Graphics (Y/N)	Portable (Y/N)	Color (Y/N)	Display	Screen format (col. x lines)	Price ($)
HARRIS CORP.									
8675	N	Y	N	Y	N	N	12-in. green CRT	80 x 25	1195
8685	N	Y	N	Y	N	N	12-in. green CRT	80 x 25	1950
8686	N	Y	N	Y	N	N	12-in. green CRT	80 x 25	1950
HAZELTINE CORP.									
Esprit	N	Y	N	N	N	N	12-in. green CRT	80 x 24	595
Esprit II	N	Y	N	N	N	N	12-in. green CRT	80 x 24	645
Esprit III	N	Y	N	Y	N	N	12-in. green CRT	80 x 25	895
Executive 10	N	Y	N	Y	N	N	12-in. green CRT	80 x 25	1195
Executive 80/20	N	Y	N	Y	N	N	15-in. yellow/green CRT	80 x 25	1250
Executive 80/30	N	Y	N	Y	N	N	15-in. yellow/green CRT	80 x 25	1400
HEATH DATA SYSTEMS									
HS19-3	N	N	Y	Y	N	N	12-in. white CRT	80 x 25	595
HS19-2	N	N	Y	Y	N	N	12-in. green CRT	80 x 25	625
HEWLETT-PACKARD CO.									
2382A	N	Y	N	Y	Y	N	9-in. B&W CRT	80 x 24	1700
2621B	N	Y	N	N	N	N	12-in. B&W/amber/green CRT	80 x 24	1595
2622A	N	Y	N	Y	N	N	12-in. B&W/amber/green CRT	80 x 24	2175
2623A	N	Y	N	Y	N	N	12-in. B&W/green/amber CRT	80 x 24	3750
2624B	N	Y	N	Y	N	N	12-in. B&W/green/amber CRT	80 x 24	3000
2626A	N	Y	N	Y	N	N	12-in. B&W/amber/green CRT	80 x 24	4350
2626W	N	Y	N	Y	N	N	12-in. B&W/green CRT	80 x 26	4950
2626W	N	Y	N	Y	N	N	12-in. B&W/amber/green CRT	80 x 24	4950
2645A	N	Y	N	Y	N	N	11-in. B&W CRT	80 x 24	4550
2647F	N	N	Y	Y	N	N	11-in. B&W CRT	80 x 24	9950
2648A	N	Y	N	Y	N	N	11-in. B&W CRT	80 x 24	7100
HITACHI, LTD.									Did not respond;
HMW DATA SYSTEMS, GMBH									
Color 1	N	N	Y	N	N	N	13-in. 32-color CRT	80 x 24/48	4000
Color 2001	N	N	Y	N	N	N	13-in. 8-color CRT	80 x 24/48	3000
Color 4001	N	N	Y	Y	N	N	13-in. 8-color CRT	80 x 24/48	6000
HMW ENTERPRISES									
9081	N	N	Y	Y	N	Y	19-in. 8-color CRT	80 x 48	5042
9083-S	N	N	Y	Y	N	Y	13-in. 8-color CRT	80 x 48	4042
9203	N	N	Y	Y	N	Y	13-in. 8-color CRT	80 x 48	6042
HONEYWELL, INC.									
VIP7300	N	Y	N	Y	N	N	12-in. green CRT	80 x 25	1900
VIP7801	N	Y	N	Y	N	N	12-in. green/B&W CRT	80 x 25	3175
VIP7802	N	Y	N	Y	N	N	15-in. green/B&W CRT	80 x 25	3515
VIP7804	N	Y	N	Y	N	N	12-in. green/B&W CRT	80 x 25	3365

Interfaces	Specify fonts	Special features
RS232	128 ASCII	block mode characters, message transmission modes
RS232, RS422	128 ASCII	numeric keypad, 20 PF keys, auxiliary port
RS232, RS422	128 ASCII	industry standard keyboard layout
RS232, current loop	Spanish, English, Italian, French, German	bidirectional auxiliary port, buffered
RS232, current loop	Spanish, English, Italian, French, German	detached keyboard, bidirectional auxiliary port, buffered
RS232, current loop	Spanish, English, German, French, Italian	printer buffer, printer buffer auxiliary port, 22 function keys
current loop, RS232	U.K., French, German, Spanish, Scandinavian	programmable function keys, split screen
current loop, RS232	U.K., French, German, Spanish, Scandinavian	programmable function keys, split screen
current loop, RS232	U.K., French, German, Spanish, Scandinavian	2-page memory, programmable function keys, split screen
RS232	ASCII	DEC VT-52 software compatible, 8 PF keys
RS232	ASCII	DEC VT-52 software compatible, 8 PF keys
RS232	foreign, line drawing	8 soft keys, detached keyboard
RS232, 20mA loop, RS422	foreign	8 soft keys, numeric pad, detached keyboard
RS232, 20mA loop, RS422	foreign, line drawing	8 soft keys, numeric pad, detached keyboard
RS232, RS422, 20mA loop	foreign, line drawing	8 soft keys, numeric pad, Tektronix 4010 emulation
multipoint, RS232, RS422, 20mA loop	foreign, large, math, line drawing	8 soft keys, numeric pad
multipoint, RS232, RS422, 20mA loop	foreign, line drawing	8 soft keys, numeric pad, multiple windows
RS232, RS422, multipoint	ASCII, line drawing, foreign, italics	downloadable features, multiple windows, field edit checks
multipoint, RS232, RS422, 20mA loop	foreign, line drawing	WP functions, 8 soft keys, numeric pad
RS232, RS422, 20mA loop, parallel	ASCII, line drawing, large, math, foreign	field edit checks, 8 soft keys
RS232, RS422, shared peripheral	ASCII, line drawing, large, math	8 soft keys, integral disk drive
RS232, RS422, 20mA loop, parallel, multipoint	ASCII, line drawing, large, math	field edit checks, 8 soft keys, vector generator
see directory for address		
RS232	512 displayable	programmable keyboard
RS232	128 displayable	
RS232	256 displayable	dual micro-based
RS232, 20mA loop	large, small, 256 special	user accessible micro, 32K RAM optional
RS232, 20mA loop	large, small, 256 special	user accessible micro, 32K RAM optional
RS232, 20mA loop	large, small, 256 special	ruggedized, user accessible micro, 32K RAM optional
RS232, current loop, MIL188	line graphics	choice of WP, data-entry, general-purpose keyboards
RS232, current loop, MIL188	line graphics	
RS232, current loop, MIL188	line graphics	
RS232	line graphics	

ALPHANUMERIC TERMINALS

Company Model	Dumb (Y/N)	Editing (Y/N)	Intelligent (Y/N)	Graphics (Y/N)	Portable (Y/N)	Color (Y/N)	Display	Screen format (col. x lines)	Price ($)
VIP7805	N	Y	N	Y	N	N	12-in. green/B&W CRT	80 x 25	3705
HUMAN DESIGNED SYSTEMS, INC.									
Concept 108 ASCII	N	Y	N	Y	N	N	12-in. B&W/green/amber CRT	80/132 x 25	1575
Concept APL/8	N	Y	N	Y	N	N	B&W/green/amber CRT	80/132 x 25	1750
IBM CORP.									Did not respond;
ICL, LTD.									Did not respond;
ICOT CORP.									
700/701	N	Y	N	N	N	N	12-in. green CRT	64/132 x 17/44	
ID SYSTEMS CORP.									
ID-100VA	N	N	Y	Y	N	Y	12-in. 8-color CRT	80/132 x 24	4395
ID-100VB	N	N	Y	Y	N	Y	12-in. 8-color CRT	80/132 x 24/48	5895
INDUSTRIAL DATA TERMINAL CORP.									
IDT-2200	N	N	Y	Y	N	Y	19-in. 8-color CRT	85 x 51	11995
INFORMER, INC.									
401	Y	N	N	N	N	N	9-in. green CRT	80 x 24	690
D-304	N	Y	Y	N	N	N	9/12-in. B&W CRT	80 x 24	1650
D-375	N	Y	N	N	N	N	9/12-in. B&W CRT	80 x 25	2400
D-377	N	Y	N	N	N	N	9-in. green CRT	80 x 25	1700
I-304	N	Y	N	N	N	N	9-in. B&W CRT	80 x 24	1800
I-375	N	Y	N	N	N	N	9-in. B&W CRT	80 x 25	2500
I-377	N	Y	N	N	N	N	9-in. green CRT	80 x 25	1800
R301/311	Y	N	N	N	N	N	5-in. B&W CRT	32/64 x 16	2025
INTEGRATED DATA SYSTEMS, INC.									
ID-212	N	Y	N	Y	Y	Y	12-in. 8-color CRT	80 x 24	1695, Q25
ID-813	N	Y	N	Y	Y	Y	14-in. 8-color CRT	80 x 32	2045, Q25
ID-819	N	Y	N	Y	Y	Y	19-in. 8-color CRT	80 x 48	3145, Q25
INTELLIGENT SYSTEMS CORP.									
2405	N	N	Y	Y	N	Y	13-in. 16-color CRT	80 x 24	1495, Q100
8001G	N	N	Y	Y	N	Y	19-in. 16-color CRT	80 x 48	2095, Q100
8001R	N	N	Y	Y	N	Y	19-in. 16-color CRT	80 x 48	2995, Q100
INTERFACE TECHNOLOGY, INC.									Did not respond;
INTERNATIONAL ENTRY SYSTEMS, INC.									
I	N	Y	N	N	Y	N	B&W LCD	16 x 1	2000
INTERTEC DATA SYSTEMS CORP.									
Emulator	N	Y	N	N	N	N	12-in. B&W CRT	80 x 25	
Intertube III	N	Y	N	Y	N	N	12-in. B&W CRT	80 x 25	895
ITT-COURIER									
2700-XX	N	Y	N	N	N	Y	14-in. 6-color CRT	80/132 x 25/44	
2780-XX	N	Y	N	N	N	N	15-in. green CRT	80/132 x 25/44	
C700				N	N	N	15-in. green CRT	80/132 x 25/44	
KIMTRON CORP.									
ABM 85	N	Y	N	Y	N	N	12-in. green CRT	80 x 25	850

Interfaces	Specify fonts	Special features
RS232	line graphics	
RS232C standard, 20mA optional	upper/lower case ASCII	4-page memory, 80/32 columns, windowing, networking, others
RS232 standard, 20mA optional	upper/lower ASCII, APL	4-page memory, 80/132 columns, windowing, networking, others
see directory for address		
see directory for address		
RS232, RS422	two or four character sets	IBM 3278-compatible
RS232	2 character sets, line drawing set, others	
RS232	2 character sets, line drawing set, 2 symbol	
RS232, parallel, 20mA loop	ASCII, large, small, custom	graphics software
RS232	ASCII 7X9	
RS232, 20mA	ASCII 7X9	4 screen sizes, block/interactive
RS232	ASCII, 7X9	IBM 3275-compatible
RS232	ASCII 7X9	requires 374 controller
RS232, 20mA	ASCII 7X9	wood case
RS232	ASCII 7X9	IBM 3275-compatible, wood case
RS232	ASCII 7X9	requires 374 controller
RS232	USACII 5X7	rack mount
RS232 or current loop	128 ASCII plus 128 user-defined	detachable keyboard, direct cursor positioning
RS232 or 20mA current loop	128 ASCII plus 128 prog.	detachable keyboard, direct cursor positioning
RS232 or 20mA current loop	128 ASCII plus 128 prog.	detachable keyboard, direct cursor positioning
RS232C, 20mA loop	64 ASCII standard, 32 lower case optional	
RS232C, 20mA loop standard, parallel optional	64 ASCII plus 64 ISA graphics standard	
RS232C, 20mA loop standard, parallel optional	64 ASCII plus 64 ISA graphic standard	
see directory for address		
RS232	N/A	offline to cassettes, on-line async or bisync
2 simplified RS232	96 ASCII codes	
2 simplified RS232	96 ASCII codes, 11 graphic symbols	self-test, addressable cursor, read terminal status
ITT controllers		also operates stand-alone
IBM controllers		remote and local controllers optional
IBM controllers		remote and local controllers optional
RS232	ASCII, graphics, international	expandability space for additional PCB, disks, power supply

ALPHANUMERIC TERMINALS

Company Model	Dumb (Y/N)	Editing (Y/N)	Intelligent (Y/N)	Graphics (Y/N)	Portable (Y/N)	Color (Y/N)	Display	Screen format (col. x lines)	Price ($)
KG-132	N	Y	N	Y	N	N	12-in. green CRT	80 x 25	1400
LANPAR, LTD.									Did not respond;
LEAR SIEGLER, DATA PRODUCTS DIV.									
ADM 21	N	Y	N	Y	N	N	12-in. B&W/green CRT	80 x 24	695
ADM 31	N	Y	N	Y	N	N	12-in. B&W/green CRT	80 x 24/48	1095
ADM 36	N	Y	N	Y	N	N	12/15-in. B&W/green CRT	80/132 x 24	
ADM 22	Y	N	N	Y	N	N	12-in. green CRT	80 x 24	695
ADM 32	N	Y	N	Y	N	N	12/15-in. B&W/green CRT	80 x 24/48	1295
ADM 3A	Y	N	N	Y	N	N	12-in. B&W/green CRT	80 x 24	595
ADM 42	N	Y	N	Y	N	N	15-in. B&W/green CRT	80 x 25	2195
ADM 5	Y	N	N	Y	N	N	12-in. B&W/green CRT	80 x 24	645
LEE DATA CORP.									
1218	Y	N	N	N	N	N	15-in. green CRT	80 x 24	2016
1220	Y	N	N	N	N	N	15-in. green CRT	80/132 x 24/43	3034
1230/1231	Y	N	N	N	N	Y	15-in. 4-color CRT	80 x 24/32	3936
LEXICON, INC.									Did not respond;
LIBERTY ELECTRONICS									
Freedom 100	Y	N	N	Y	N	N	12-in. green CRT	80 x 25	595
LOGICON-INTERCOMP									Did not respond;
LYNWOOD SCIENTIFIC DEVELOPMENTS LTD.									
Alpha Colour	N	N	Y	Y	N	N	15-in. green CRT	80 x 30	5934
Alpha Graphic	N	N	Y	Y	N	N	15-in. green CRT	80 x 30	4214
Beta	N	N	Y	N	N	N	15-in. green CRT	80 x 30	2315
MATROX ELECTRONIC SYSTEMS LTD.									
CTM-300	N	N	Y	Y	Y	Y	12-in. black CRT	80/132 x 25	3240
MDS TRIVEX									
8078	N	Y	N	N	N	N	15-in. yellow/green CRT	80 x 43	1700
MEGADATA CORP.									
8188	N	N	Y	Y	N	Y	15-in. any CRT	132 x 30	3000, Q50
MEMOREX CORP.									
1377	Y	N	N	N	N	N	15-in. green CRT	80 x 24	2200
2078	Y	N	N	Y	N	N	15-in. green CRT	80 x 12/43	1680-2535
2079S2A	Y	N	N	Y	N	Y	13-in. 4-color CRT	80 x 24	3289
2079 Model 2X	Y	N	N	Y	N	Y	13-in. 4-color CRT	80 x 24	3374
2079 Model 3X	Y	N	N	Y	N	Y	13-in. 4-color CRT	80 x 32	3701
2079 Model 3X with feature 3850	Y	N	N	Y	N	Y	13-in. 7-color CRT	80 x 24	3701
2079S2B	Y	N	N	Y	N	Y	13-in. 7-color CRT	80 x 24	3646
2079S3G	Y	N	N	Y	Y	Y	13-in. 7-color CRT	80 x 32	5116
2079 Model 2X with feature 3850	Y	N	N	Y	N	Y	13-in. 7-color CRT	80 x 24	3374

Interfaces	Specify fonts	Special features
RS232	ASCII, graphics, international	expandability to intelligent terminal, space for additional PCB
see directory for address		
RS232, 20mA current loop optional	ASCII, French, Swedish/Finnish, UKASCII	block or conversation full screen reverse, dio visual, others
RS232, current loop, direct connect	USASCII, UKASCII	printer, polling, 2-page memory
RS232, current loop, RS422	USASCII, UKASCII, French, Spanish, italics, others	DEC VT-100-compatible, advance video and printer optional
RS232, current loop	USASCII	compatible with LSI 3A, 5, & 31, Hazeltine 1500, ADDS Regent
RS232, current loop, direct connect	UKASCII, USASCII	printer port, 2 pages, smooth scroll, X-ON, X-OFF, function keys
RS232, 20mA current loop-gated extension port	ASCII, some foreign available	gated extension port, white or green phosphor
RS232, current loop	USASCII, UKASCII	16 function keys, 4-page memory
RS232, 20mA current loop	ASCII, some foreign available	program mode built in numeric key pad, white/green phosphor
Lee Data 300 control unit		
Lee Data 300 and 400 control units		multiple screen sizes
Lee Data 300 and 400 control units, IBM 3279		
see directory for address		
2 bidirectional RS232C ports or 20mA current loop	many foreign	emulates ADM-3A, 5, Hazeltine 1420, ADDS Regent 25
see directory for address		
3 synchronous ports, line printer, auxiliary	user-programmable	split screen, video attributes, 8-color graphics, calculator
3 synchronous ports, line, printer, auxiliary	user-programmable	split screen, video attributes, 192K-bytes memory
3 synchronous ports, line, printer, auxiliary	user-programmable	ergonomic design, video attributes, 10 function keys, 12 macro
host: RS232C; printer: parallel, light pen	256 characters, European	ANSI X3.64 standard firmware, 18 user-definable keys
		many
RS232, RS449, RS170, high-speed specials	any	16-bit micro, 128K-byte RAM, 155-key keyboard, 3 ports
RS232	EBCDIC, ASCII	
RS232	EBCDIC, ASCII, APL/text	IBM 350, 370, 303X, 4300, 8100-compatible
RS232	EBCDIC, ASCII, APL/text	IBM 350, 370, 303X, 4300, 8100-compatible
RS232	EBCDIC, ASCII, APL/text	IBM 350, 370, 303X, 4300, 8100-compatible
RS232	EBCDIC, ASCII, APL/text	IBM 350, 370, 303X, 4300, 8100-compatible
RS232	EBCDIC, ASCII, APL/text	IBM 350, 370, 303X, 4300, 8100-compatible
RS232	EBCDIC, ASCII, APL/text	IBM 350, 370, 303X, 4300, 8100-compatible
RS232	EBCDIC, ASCII, APL/text	IBM 350, 370, 303X, 4300, 8100-compatible
RS232	EBCDIC, ASCII, APL/text	IBM 350, 370, 303X, 4300, 8100-compatible

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Company Model	Dumb (Y/N)	Editing (Y/N)	Intelligent (Y/N)	Graphics (Y/N)	Portable (Y/N)	Color (Y/N)	Display	Screen format (col. x lines)	Price ($)
2051 Model II	Y	N	N	N	N	N	15-in. green CRT	80 x 24	
MICON INDUSTRIES									Did not respond;
MICRO-TERM, INC.									
Ergo 2000	N	Y	N	Y	N	N	12-in. green CRT	80 x 24	1195
Ergo 3001	N	Y	N	Y	N	N	12-in. green CRT	132 x 25	1495
Ergo 4000	N	Y	N	Y	N	N	15-in. green CRT	80 x 66	1695
Mime 340	N	Y	N	Y	N	N	12-in. green CRT	80 x 24	750
Mime 740	N	Y	N	Y	N	N	12-in. green CRT	132 x 25	1295
Mime-2A	N	Y	N	Y	N	N	12-in. green CRT	80 x 24	1045
MICRODATA CORP.									
5750	N	N	Y	N	N	N	12-in. B&W CRT	80 x 25	5100
7350/60	Y	N	N	Y	N	N	12-in. B&W CRT	80 x 25	1825
7450	N	N	Y	N	N	N	9-in. B&W CRT	40 x 13	1990
7510	N	N	Y	N	N	N	12-in. B&W CRT	80 x 25	6825
Prism II	Y	N	N	N	N	N	12-in. B&W CRT	80 x 24	2200
Prism IV				N			12-in. green CRT	80 x 25	2200
MICROPAD, INC.									Did not respond;
MILTOPE CORP.									
Milterm 200	Y	N	N	Y	Y	N	10-in. plasma panel	40 x 8	12000
Milterm 280	Y	N	N	Y	Y	N	10-in. plasma panel	80 x 25	16000
MOHAWK DATA SCIENCES									Did not respond;
MULTITECH INDUSTRIAL CORP.									
D75	N	Y	N	Y	N	N	15-in. B&W CRT	80 x 25	495
NABU COMMERCIAL TERMINALS									
Nabu 3100	N	Y	N	N	N	N	12-in. B&W/amber/green CRT	80 x 24	1095
Nabu 414H	N	Y	N	N	N	N	12-in. B&W/amber/green CRT	80 x 24	1095
Nabu 4152	Y	N	N	N	N	N	12-in. B&W/amber/green CRT	80 x 25	1095
Nabu 415APL	N	Y	N	N	N	N	12-in. B&W/amber/green CRT	80 x 25	1295
Nabu 4404	Y	N	N	N	N	N	12-in. B&W/amber/green CRT	80 x 24	695
Nabu 4404-GX	Y	N	N	Y	N	N	12-in. B&W/amber/green CRT	80 x 25	
Nabu 4503	Y	N	N	N	N	N	12-in. green CRT	80 x 24	450
NCR CORP.									
7900-1311	N	Y	N	Y	N	N	12-in. green CRT	80 x 25	3670
7900-1412	N	Y	N	Y	N	N	12-in. green CRT	80 x 25	2495
7900-2112	Y	N	N	N	N	N	12-in. green CRT	80 x 25	1500
7901-0101	Y	N	N	N	N	N	12-in. green CRT	80 x 24	850
NETCOM PRODUCTS, INC.									Did not respond;
NORAND CORP.									Did not respond;
NORSK DATA, AS									Did not respond;
NORTHERN TELECOM SYSTEMS CORP.									Did not respond;
NOVELL DATA SYSTEMS, INC.									Did not respond;

Interfaces	Specify fonts	Special features
RS232	EBCDIC	IBM 34/38-compatible
see directory for address		
RS232		block mode, protected fields, printer port, smooth scroll, others
RS232	9X11	double high/wide, scrolling window, advanced video, printer port
RS232	5X7	alternate character set, 4 video attributes, printer port, 15 PF keys
RS232		block mode, protected fields, printer port
RS232		double high/wide, scrolling window, advanced video, printer port
RS232, current loop		block mode, protected fields, printer port, smooth scroll, others
RS232	96 ASCII	IBM 27XX, 37XX emulation, 2-page memory, numeric and function pads
	96 ASCII	half bright, blink, underline, reverse video
	64 ASCII	
	96 ASCII	half bright, blink, underline, reverse video
RS232	ASCII	self-test, detachable keyboard, selectable cursor, numeric pad
RS232	96 ASCII	tilt/swivel screen, function keys, numeric pad
see directory for address		
RS232, PDP-11, NTDS	ASCII, dot graphics	a militarized portable terminal
RS232, PDP-11, NTDS	ASCII, dot graphics	a militarized portable terminal
see directory for address		
RS232 Centronics parallel		uses 24 keys for input; outputs 22,000 Chinese characters, others
RS232C	31 graphic characters	4 highlighting attributes, bidirectional smooth scroll, others
RS232C		Hazeltine 1510-compatible, direct X-Y cursor address, others
RS232C		detached keyboard, scrolling, horizontal tabs, transparent mode
RS232C	APL, ASCII	character rub-out in APL interactive mode, independent
RS232C		Lear Siegler ADM-3A-compatible, detached keyboard, character highlighting
RS232C	standard	ADM-3A-compatible, PLOT-10 and GINO-F software-compatible, others
		absolute and relative cursor addressing, detached keyboard
RS232, polled, parallel	17 foreign optional	detached keyboard
RS232	17 foreign optional	detachable keyboard
RS232	17 foreign optional	detached keyboard
RS232	6 foreign	screen attitude adjust, detached keyboard
see directory for address		
see directory for address		
see directory for address		
see directory for address		
see directory for address		

ALPHANUMERIC TERMINALS

Company Model	Dumb (Y/N)	Editing (Y/N)	Intelligent (Y/N)	Graphics (Y/N)	Portable (Y/N)	Color (Y/N)	Display	Screen format (col. x lines)	Price ($)
ONTEL CORP.									
1503	N	N	Y	Y	N	N	15-in. B&W/green/amber CRT	80 x 25	1195, Q250
1505	N	N	Y	Y	N	N	15-in. B&W/green/amber CRT	80 x 25	1495, Q100
1507	N	N	Y	Y	N	N	15-in. B&W/green/amber CRT	80 x 25	2695, Q100
Amigo	N	N	Y	Y	N	N	12-in. green CRT	80 x 25	1100, Q500
OTTO ELECTRONICS									Did not respond;
PARADYNE CORP.									
9440	N	Y	N	N	N	N	15-in. green CRT	80 x 25	3000
9476	N	N	Y	N	N	N	15-in. green CRT	80 x 25	5850
9478	N	N	Y	N	N	N	15-in. green CRT	80 x 25	3000
PERRY DATA SYSTEMS									
9460	N	Y	N	Y	N	N	12-in. green CRT	80 x 24	2995
PERTEC COMPUTER CORP.									Did not respond;
PHOENIX COMPUTER GRAPHICS									Did not respond;
PIICEON, INC.									
System I	N	N	Y	N	N	N	15-in. green CRT	80 x 33/66	1508, Q1500
System II	N	N	Y	N	N	N	15-in. green CRT	80 x 33/66	1833, Q1500
System III	N	Y	N	N	N	N	15-in. green CRT	80 x 33/66	3666, Q1500
PLESSEY PERIPHERAL SYSTEMS									Did not respond;
PSITECH									
GT212/GT215	N	N	Y	Y	N	N	12/15-in. B&W CRT	85 x 24/48	4500
GTC214/GTC519	N	N	Y	Y	N	Y	14/19-in. 8-color CRT	85 x 48	8750
QUADRAM CORP.									
MX-700	N	Y	N	Y	N	N	17-in. green CRT	160 x 66	1975, Q25
RACAL-MILGO COMPUTER PRODUCTS DIV.									
4015	N	Y	N	N	N	N	15-in. green CRT	80 x 24	4155
4220/U200	N	Y	N	N	N	N	15-in. green CRT	80 x 12/24	3370
4220/UTS20	N	Y	N	N	N	N	15-in. green CRT	80 x 12/24	3370
4276	N	Y	N	N	N	N	15-in. green CRT	80 x 24	3950
4276	N	Y	N	N	N	N	15-in. green CRT	80 x 24	3555
4278	N	Y	N	N	N	N	15-in. green CRT	80 x 24	2560
SCI SYSTEMS, INC.									
2404 I, K, 2405	N	N	Y	N	N	N	9-in. green/B&W CRT	40/80 x 24	
SIEMENS CORP.									
T4200/40	N	Y	N	N	N	N	12-in. B&W CRT	82 x 21	7000
Series 4100	N	Y	N	N	N	N	12-in. B&W CRT		2500
SOLID STATE TECHNOLOGY, INC.									
8100 Series	N	N	Y	N	N	N	12-in. B&W CRT	80 x 25	2995, Q200
SOROC TECHNOLOGY, INC.									
Challenger	N	Y	N	Y	N	N	12-in. green CRT	80 x 25	399, Q200
IQ 130	N	Y	N	Y	N	N	12-in. green CRT	80 x 25	490, Q200
IQ 135	N	Y	N	Y	N	N	12-in. green CRT	80 x 25	600, Q200

Interfaces	Specify fonts	Special features
async, sync comm.; serial, parallel printer	128 characters in PROM	64K-byte memory, detachable keyboard, printer port, display attributes
async, sync comm.; serial, parallel printer	256 characters in PROM	64K-byte memory, printer port, DMA controller, display attributes
async, sync comm.; serial, parallel printer	256 characters in PROM	64K-byte memory, detachable keyboard, 4 DMA controllers
RS232, parallel	user-programmable, 640X300 dot graphics	64K-byte user memory, 44K-byte display buffer, detachable keyboard
see directory for address		
774		
3270 loop		IBM 3276
3270 loop		IBM 3278
2 each RS232/422	USASCII	point-of-sale terminal for use with mini-based POS system, others
see directory for address		
see directory for address		
2 serial, 1 parallel		8086 CPU, 128K RAM
2 serial, 1 parallel		8086 CPU, 128K RAM, .5M-byte floppy
2 serial, 1 parallel		8086 CPU, 128K RAM, .5M-byte floppy, 12.76M-byte Winchester
see directory for address		
RS232	user-definable	software-defined character sets, overstrike capabilities
RS232	user-definable	programmablel line types, programmable Bell, subscripts, others
RS232 printer parallel		32 graphic symbols, double wide/high, serial 110, 960X528 graphing
RS232C, Bell 8A1	ASCII	alarm, tilt, swivel, 8-page memory, 6 PF keys
RS232C, Univac U100, U200	ASCII	alarm, tilt, swivel, 4 PF keys
RS232C, Univac UTS20	ASCII	alarm, tilt, swivel, 22 PF keys
IBM 3275/3276, RS232C	ASCII, EBCDIC	alarm, tilt, swivel, 24 PF keys
RS232C, Bell 8A1	ASCII	alarm, 8-page memory, tilt, swivel, 6 PF keys
IBM 3270	ASCII, EBCDIC	alarm, tilt, swivel, 24 PF keys
card reader, RS232, diskette		integral high-speed electrostatic printer
Teletex		daisywheel printer standard
TELEX, TWX		price varies with communication options
RS232C, 20mA	256 displayable characters	multitasking, 5¼-in. floppy, integral printer, BASIC, COBOL
RS232		separate kybd, 14 programmable functions
RS232		14 programmable functions
RS232		separate keyboard, tilt, swivel, 14 programmable functions

ALPHANUMERIC TERMINALS

Company Model	Dumb (Y/N)	Editing (Y/N)	Intelligent (Y/N)	Graphics (Y/N)	Portable (Y/N)	Color (Y/N)	Display	Screen format (col. x lines)	Price ($)
IQ 150	N	Y	N	Y	N	N	12-in. green CRT	80 x 25	895, Q200
SOUTHWEST DATA SYSTEMS									Did not respond;
SOUTHWEST TECHNICAL PRODUCTS CORP.									Did not respond;
SPERRY UNIVAC									
UTS-10	Y	N	N	N	N	N	12-in. green CRT	80 x 25	1428
UTS-20	N	Y	N	N	N	N	12-in. green CRT	80 x 25	3300
UTS-40	N	N	Y	N	N	N	12-in. green CRT	80 x 25	4600
SRA COMMUNICATIONS, AB									
SRA 11	Y	N	N	N	N	N	15-in. yellow	80 x 24/36	
STEINMETZ, KRISCHKE, SYSTEM TECHNIK, GMBH									Did not respond;
STERIA-INGENIERIE									Did not respond;
SYSTEMATICS GENERAL CORP.									Did not respond;
TAB PRODUCTS CO.									
132/15	N	Y	N	Y	N	N	15-in. green CRT	132 x 27	2100
132/15-G	N	Y	N	Y	N	N	15-in. green/B&W CRT	132 x 27	3295
TANDBERG DATA, INC.									
TDV2220	N	Y	N	Y	N	N	15-in. green CRT	80 x 24/25	
TEC, INC.									
TEC 510/610	Y	N	N	Y	N	N	12-in. grey CRT	80 x 25	900
TEC 570/670	N	Y	N	Y	N	N	12-in. grey/green CRT	80 x 25	1600
TEC 630	N	Y	N	Y	N	N	12-in. grey/green CRT	80 x 25	1400
TEC ET-80	N	Y	N		N	N	15-in. grey CRT	80/132 x 25	2000
TEKTRONIX, INC.									
4025A	N	Y	N	Y	N	N	12-in. CRT	80 x 34	5900
TELCON INDUSTRIES									Did not respond;
TELEFUNKEN CORP., AEG									Did not respond;
TELEPAR, INC.									
IT801	N	Y	N	Y	N	Y	12-in. 8-color CRT	80 x 25	2350, Q100
TELERAM COMMUNICATIONS CORP.									
3000	N	N	Y	N	Y	N	4- line LCD	80 x 4	
TELERAY									
16	N	Y	N	Y	N	N	12-in. B&W/green/amber CRT	80 x 25	
TELETYPE CORP.									
4420	N	Y	N	N	N	N	13-in. B&W CRT	80 x 24	4105
4424	N	Y	N	Y	N	N	13-in. B&W CRT	80 x 24	4207
4430	N	Y	N	N	N	N	13-in. B&W CRT	80 x 24	4245
4540	N	Y	N	N	N	N	13-in. B&W CRT	80 x 25	2627
4543	N	Y	N	N	N	N	13-in. B&W CRT	80 x 24	4575
TELEVIDEO SYSTEMS, INC.									
910	Y	N	N	N	N	N	12-in. green CRT	80 x 24	699
910+	N	Y	N	N	N	N	12-in. green CRT	80 x 24	699
925	N	Y	N	N	N	N	12-in. green CRT	80 x 24	995

interfaces	Specify fonts	Special features
RS232	alternate character sets	120-line memory, 128 programmable function keys, smooth scroll
see directory for address		
see directory for address		
RS232 or current loop	foreign	Teletype-compatible
RS232, CCITT V.24	foreign	tilt/swivel screen
RS232, CCITT V.24	foreign, user-programmable	64K-byte memory, tilt/swivel base
IBM S/34, S/38, 5251-12		dimming, adjustable key click and alarm
see directory for address		
see directory for address		
see directory for address		
RS232, 20mA loop, 60mA loop	ASCII and business graphics	detachable keyboard, video attributes
RS232, 20mA loop, 60mA loop	ASCII and business graphics	detachable keyboard, video attributes
RS232, RS422, current loop	foreign, graphics	ergonomic design; keylock optional
RS232		self-test
RS232		
RS232		scroll through, 2-page memory
RS232, RS422		flickerless display, scroll, smooth/jump, 5-page memory
RS232	ASCII	definable keys, split screen
see directory for address		
see directory for address		
RS232C and 20mA current loop	96 ASCII, 128 graphic symbols	RS170 outputs, printer port, 109-key keyboard
RS232		9 pounds, CP/M operating system, 256K-byte memory
	128 ASCII, 128 graphics	function keys
EIA RS232C, display and printer ports	ASCII	5K-byte buffer, PF keys, self-diagnostics
EIA RS232C, display and printer ports	ASCII	3K-byte buffer, PF keys, split screen, ophons menu
EIA RS232C, display and printer ports	ASCII	multi-point poll selectable, 5K-byte buffer, self-diagnostics, others
EIA RS232C	EBCDIC/ASCII	IBM 3270 BSC/SDLC-compatible
EIA RS232C	EBCDIC/ASCII	IBM-compatible
RS232C	English, French, German, Spanish	emulates ADM 3A/5, ADDS 25, Hazeltine 1410
RS232C	English, French, German, Spanish	block mode, local editing
RS232C	English, French, German, Spanish	function keys, detachable keyboard, bidirectional, page, transparent, print

ALPHANUMERIC TERMINALS

Company Model	Dumb (Y/N)	Editing (Y/N)	Intelligent (Y/N)	Graphics (Y/N)	Portable (Y/N)	Color (Y/N)	Display	Screen format (col. x lines)	Price ($)
950	N	Y	N	Y	N	N	12-in. green CRT	80 x 24	1195
970	N	Y	N	Y	N	N	14-in. green CRT	80/132 x 24	1500
TELEX COMPUTER PRODUCTS, INC.									
178	Y	N	N	N	N	Y	12-in. CRT	80 x 24	2805
278	N	Y	N	N	N	N	15-in. CRT	80/132 x 24/43	2350
279	N	Y	N	N	N	N	14-in. CRT	80 x 24	3900
TELEX TERMINAL COMMUNICATIONS, INC.									Did not respond;
TERAK CORP.									Did not respond;
TERMIFLEX CORP.									Did not respond;
TERMINAL DATA CORP.									Did not respond;
TEXAS INSTRUMENTS, INC.									
Opti 940	N	Y	N	N	N	N	12-in. black	12/24 x 80/132	1895
TYMSHARE, INC.									
Scanset	Y	N	N	N	N	N	green CRT	80 x 25	
UTEC CORP.									Did not respond;
VIDEO DATA SYSTEMS									Did not respond;
VISUAL TECHNOLOGY, INC.									
V100	N	Y	N	N	N	N	12/14-in. green CRT	80/132 x 24	1345
V110	N	Y	N	N	N	N	12/14-in. green CRT	80/132 x 24	1395
V300/330	N	Y	N	N	N	N	12/14-in. green CRT	80 x 24	1150
V50	N	Y	N	N	N	N	12-in. green CRT	80 x 24	695
V500	N	Y	N	Y	N	N	14-in. green CRT	80 x 33	2395
V550	N	Y	N	Y	N	N	14-in. green CRT	80 x 33	2595
WANG LABORATORIES, INC.									
5536-4	N	Y	N	N	N	N	12-in. green CRT	80 x 24	4900
Ergo 2	N	Y	N	N	N	N	12-in. green CRT	80 x 24	5200
Ergo 3	N	Y	N	N	N	N	12-in. B&W CRT	80 x 24	5300
Professional Computer	N	N	Y	Y	N	Y	12-in. CRT	80 x 25	2700
WARREN LOGIC, LTD.									Did not respond;
WENGER DATEN TECHNIK									Did not respond;
WESTINGHOUSE CANADA, LTD.									Did not respond;
WORDPLEX CORP.									Did not respond;
ZENITH DATA SYSTEMS									
ZT-1	N	Y	N	N	Y	N	12-in. green CRT	80 x 25	699
Z19	N	Y	N	Y	Y	N	12-in. green CRT	80 x 25	895
ZENTEC CORP.									
8000	N	N	Y	N	N	N	12-in. green/B&W/amber CRT	80 x 25	1200, Q250
Cobra	N	Y	N	N	N	N	12-in. green CRT	80 x 25	875, Q250
Zephyr	N	Y	N	N	N	N	12-in. B&W CRT	80 x 25	800, Q250
ZMS-35	N	Y	N	N	N	N	12-in. B&W CRT	80 x 25	950, Q250

Interfaces	Specify fonts	Special features
RS232C	English	buffered print, PF keys
RS232C	French, German, Spanish, English, Danish	ANSI 3.64, VT-100-compatible, logical attributes, others
IBM 3274/3276, Telex 174/276		over 30 keyboard selections
IBM 3274/3276, Telex 174/276		over 30 keyboard selections
IBM 3274/3276, Telex 174/276		over 30 keyboard selections
see directory for address		
see directory for address		
see directory for address		
see directory for address		
EIA RS232C	7X9	vertical, horizontal screen splits, 1-page memory, others
RS232	ASCII	a compact terminal for database access
see directory for address		
see directory for address		
RS232, 20mA	8 foreign, line drawing	VT-100, VT-52 emulation, buffered printer port, smooth scrolling
RS232, 20mA	8 foreign, line drawing	DG D200 emulation, smooth scrolling
RS232, 20mA	8 foreign, line drawing	VT-52, DG Dasher, Hazeltine 1500, ADM3A, ANSI 3.64 emulation, others
RS232, 20mA auxiliary port	U.S., U.K., French, German, Swedish, Norwegian	VT-52, Espirit Vuepoint, ADM3A emulations
RS232, 20mA, auxiliary port	5 foreign & math symbols	VT-52, Hazeltine 1500, DG D200, ADM3A, 4010, 4014 emulation
RS232, 20mA auxiliary port	5 foreign & math symbols	ANSI 3X64, VT-100 emulations, Tektronix 4010, 4014
RS232, optional Wang Datalink		
RS232, Wangnet optional Wang Datalink		
RS232, Wangnet, Wang Datalink		avoid: 900
RS232 synchronous, RS232 bisync	8x10	320K-byte diskette drive
see directory for address		
see directory for address		
see directory for address		
see directory for address		
RJ11	ASCII	automatic log-on to timesharing systems
RS232	ASCII with European	DEC VT-52 emulation
RS232, 20mA loop	128 ASCII standard, 224 characters optional	detached keyboard, 16K-byte memory, numeric-, function-, cursor pads
RS232, 20mA loop	128 ASCII	detached keyboard, numeric-, function-, cursor pads
RS232, 20mA loop	128 ASCII	numeric-, function-, cursor pads
RS232, 20mA loop		

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DATACQ CORP.
P 637 Ortiz Ave.
Sand City, CA 93955
(408) 899-4888
Circle 566

DATAFLUX
D 1050 Stewart Dr.
Sunnyvale, CA 94086
Circle 567

DATAMASTER INC.
D 389 N. Carmen Dr.
Camarillo, CA 93010
(805) 498-8466
Circle 568

DATAMEDIA CORP.
T 7300 N. Crescent Blvd.
Pennsauken, NJ 08110
(609) 665-5400
Circle 569

DATAPOINT CORP.
P 9725 Datapoint Dr.
San Antonio, TX 78285
(512) 699-7000
Circle 570

DATAPRODUCTS CORP.
P 6200 Canoga Ave.
Woodland Hills, CA 91365
(213) 887-8860
Circle 571

DATARAM CORP.
D Princeton-Highstown Rd.
Cranbury, NJ 08512
(609) 799-0071
Circle 572

DATAROYAL INC.
P 235 Main Dunstable Rd.
Nashua, NH 03061
(603) 883-4157
Circle 573

DATASAAB AB
D Fack S-17586
Jarfalla, Sweden
Circle 574

DATASOUTH COMPUTER CORP.
P 4216 Stuart Andrew Blvd.
Charlotte, NC 28210
(704) 523-8500
Circle 575

DATATYPE, INC.
T 2615 Miller Ave.
Mountain View, CA 94040
(415) 949-1053
Circle 576

DATAVUE CORP.
T 1911 22nd Ave. S.
Seattle, WA 98144
(206) 322-9330
Circle 577

DATEL INTERSIL INC.
P 11 Cabot Blvd.
Mansfield, MA 02048
(617) 339-9341
Circle 578

DATREX INC.
D 3101 W. Thomas Rd., Suite 109
Phoenix, AZ 85017
(602) 272-9491
Circle 579

DECISION DATA COMPUTER CORP.
P 100 Witmer Rd.
T Horsham, PA 19044
(215) 674-3300
Circle 580

DELPHAX SYSTEMS
P 977 Panteral Dr., Missisauga
Ontario, L4W 2W6, Canada
(416) 624-2643
Circle 581

DELTA DATA SYSTEMS CORP.
T 2595 Metropolitan Dr.
Trerose, PA 19047
(215) 322-5400
Circle 582

DI/AN CONTROLS INC.
P 944 Dorchester Ave.
Boston, MA 02125
(617) 288-7700
Circle 583

DIABLO SYSTEMS, INC.
P 24500 Industrial Blvd.
T Hayward, CA 94545
(415) 786-5000
Circle 584

DICOM INDUSTRIES, INC.
D 715 N. Pastoria Ave.
Sunnyvale, CA 94086
(408) 732-1060
Circle 585

DIGI-DATA CORP.
P 8580 Dorsey Run Rd.
Jessup, MD 20794
(301) 498-0200
Circle 586

DIGICO, LTD.
D Wedgewood Wa, Stevenage
T Hertfordshire, SG1 4PY, England
Circle 587

DIGITAL ASSOCIATES CORP.
P 1039 E. Main St.
Stamford, CT 06902
(203) 327-9210
Circle 588

DIGITAL DEVELOPMENT CORP.
D 8650 Balboa Ave.
San Diego, CA 92123
(714) 278-9920
Circle 589

DIGITAL EQUIPMENT CORP.
P 146 Main St.
D Maynard, MA 01654
T (617) 897-5111
Circle 590

DIP INC.
P 745 Atlantic Ave.
Boston, MA 02111
(617) 482-4214
Circle 591

DIRECT, INC.
T 1279 Lawrence Station Rd.
Sunnyvale, CA 94086
(408) 734-5504
Circle 592

DISCTRON
D 1701 McCarthy Blvd.
Milpitas, CA 95035
(408) 946-6692
Circle 593

DISK MEMORY TECHNOLOGY, INC.
D 155 B. Ave.
Lake Oswego, OR 97034
(503) 636-7675
Circle 594

DISK TEC 1
(see OHIO SCIENTIFIC MEMORY PRODUCTS)

DIVA, INC.
D 607 Industrial Way W.
Eatontown, NJ 07724
(201) 544-9000
Circle 595

DMA SYSTEMS
D 601 Pine Ave.
Goleta, CA 93117
(805) 683-3811
Circle 596

DMC SYSTEMS, INC.
T 2300 Owen St.
Santa Clara, CA 95051
(408) 727-4444
Circle 597

DORADO MICRO SYSTEMS
D 10381 Bandley Dr.
Cupertino, CA 95014
(408) 444-9778
Circle 598

DURANGO SYSTEMS, INC.
D 3003 N. First St.
San Jose, CA 95134
(408) 946-5000
Circle 599

DTI DATA TERMINALS CORP.
T 45 West St.
Medfield, MA 02052
(617) 359-4188
Circle 600

DY-4 SYSTEMS, INC.
T 888 Lady Ellen Place
Ottawa, Ontario,
K12 5M1, Canada,
(613) 728-3711
Circle 601

DYNALOGIC CORP., LTD
D 141 Bentley Ave.
Ottawa, K2E 6T7, Canada
(613) 226-1383
Circle 602

DYNEX CORP.
D 2910 N. 30th Ave.
Phoenix, AZ 85017
Circle 603

EATON CORP.
P Printer Products Operation
Riverton, WY 82501
Circle 604

ECS MICROSYSTEMS
T 215 Devcon
San Jose, CA 95112
(408) 286-4200
Circle 605

ELBIT USA
T 1350 Avenue of the Americas
New York, NY 10019
(212) 887-1510
Circle 606

ELCOMATIC, LTD.
D Kirktonfield, Nielston
Glasgow, Scotland
(041) 881-5825
Circle 607

ELECTROMAGNETIC SCIENCES
T 125 Technology Park/Atlanta
Norcross, GA 30092
(404) 448-5770
Circle 608

ELECTRONIC PRODUCTS ASSOCIATES
P 1157 Vega St.
San Diego, CA 92110
Circle 609

ENVISION
P 631 River Oaks Pkwy.
T San Jose, CA 95134
(408) 946-9755
Circle 610

EPIC COMPUTER PRODUCTS
T 18381 Bandilier Circle
Fountain Valley, CA
(716) 964-4722
Circle 611

EPSON AMERICA, INC.
P 3415 Kashiwa St.
Torrance, CA 90505
(213) 534-0360
Circle 612

EVOTEK CORP.
D 1220 Page Ave.
Fremont, CA 94538
(415) 490-3100
Circle 613

EXTEL CORP.
P 4000 Commercial
T Northbrook, IL 60062
(312) 291-2547
Circle 614

EXXON OFFICE SYSTEMS
D 329 Gordon Dr.
Lionville, PA 19353
(215) 363-3000
Circle 615

FACIT DATA PRODUCTS/DATAROYAL
P 235 Main Dunstable Rd.
T Nashua, NH 03061
(603) 833-4157
Circle 616

FALCO DATA PRODUCTS, INC.
T 1286 Lawrence Stations Rd.
Sunnyvale, CA 94086
(408) 745-7123
Circle 617

FLORIDA DATA CORP.
P 6000 John Rodes Blvd.
Melbourne, FL 32935
(305) 259-4700
Circle 618

FUJITSU
D 61 Marunouchi 2-chome
Chiyoda-ku, Tokyo 100, Japan
(03) 216-3211
Circle 619

FUJITSU AMERICA, INC.
P 2945 Oakmead Village Ct.
Santa Clara, CA 95051
(408) 727-4300
Circle 620

FUNGUS COMPUTER PRODUCTS, LTD.
T No. 1 Westmoreland House, Teall St.
Dewsbury, West Yorkshire, England
Circle 621

GENERAL AUTOMATION INC.
D 1055 South East St.
Anaheim, CA 92805
(714) 778-4800
Circle 622

GENERAL DIGITAL CORP.
T 700 Burnside Ave.
E. Hartford, CT 06108
(203) 528-9041
Circle 623

GENERAL ELECTRIC CO.
P G.E. Dr.
D Waynesboro, VA 22980
(703) 949-1188
Circle 624

GENERAL TERMINAL CORP.
T 14831 Franklin Ave.
Tustin, CA 92680
(714) 730-0123
Circle 625

GENISCO TECHNOLOGY CORP.
T 3545 Cadillac Ave.
Costa Mesa, CA 92626
(714) 565-4916
Circle 626

GR ELECTRONICS
T 1640 Fifth St., #204
Santa Monica, CA 90401
(213) 395-4774
Circle 627

GUC PRODUCTS
D 10020 Prospect Ave., Suite A-15
Santee, CA 92071
(714) 449-5775
Circle 628

GULTON INDUSTRIES, INC.
P M&S Division
Gulton Industrial Park
E. Greenwich, RI 20818
(401) 884-6800
Circle 629

HAZELTINE CORP.
T 500 Commack Rd.
Commack, NY 11725
(516) 462-5100
Circle 630

HEATH CO.
P Benton Harbor, MI 49022
D (616) 982-3200
T **Circle 631**

HEWLETT-PACKARD CO.
D 974 E. Arques Ave.
Sunnyvale, CA 94086
(408) 735-1550
Circle 632

HEWLETT-PACKARD CO.
P 1501 Page Mill Rd.
T Palo Alto, CA 94304
Circle 633

HEWLETT-PACKARD CO.
D 3400 E. Harmony Rd.
Ft. Collins, CO 80525
(303) 226-3800
Circle 634

HEWLETT-PACKARD CO.
P P.O. Box C-006
Vancouver, WA 9866
(206) 254-8110
Circle 635

HI-G
P 580 Spring St.
Windsor Locks, CT 06096
(203) 623-2481
Circle 636

HIGHTRACK COMPUTER TECHNIK GMBH
D Bundesallee 36/37
D-1000 Berlin 31, Federal Republic of Germany
(030) 86 0507
Circle 637

HITACHI AMERICA
P 100 California St.
D San Francisco, CA 94111
Circle 638

HITACHI, LTD
D Mita Ko Kusai, Bld. 1-4-28, Mita
T Minato-Ku, Tokyo 140, Japan
Circle 639

HMW DATA SYSTEM GMBH
T Siemensstrasse 14, D-8012 Ottobrun,
Federal Republic of Germany
Circle 640

HMW ENTERPRISES
T 604 Salem Rd.
Etters, PA 17319
(717) 938-4691
Circle 641

HOKUSHIN ELECTRIC WORKS, LTD.
D 30-1, Shimomaruko, 3-chome
Ohta-ku, Tokyo 146, Japan
(03) 759-4141
Circle 642

HONEYWELL INFORMATION SYSTEMS, INC.
P 200 Smith St.
D Waltham, MA 02154
T (617) 895-6000
Circle 643

HOUSTON INSTRUMENT
P 1 Houston Sq. at 8500 Cameron Rd.
Austin, TX 78753
(512) 835-0900
Circle 644

HOWARD INDUSTRIES, INC.
P 2031 E. Cerritos Ave.
Anaheim, CA 92806
(714) 778-3443
Circle 645

HUMAN DESIGNED SYSTEMS, INC.
T 3440 Market St.
Philadelphia, PA 19104
(215) 382-5000
Circle 646

IBIS SYSTEMS, INC.
D 1850 Evergreen Dr.
Duarte, CA 91010
(213) 357-2180
Circle 647

IBM CORP.
P 1133 Westchester Ave.
D White Plains, NY 10604
(914) 696-1900
Circle 648

IBM CORP.
T 900 King St.
Rye, NY 10573
Circle 649

ICL, LTD.
D ICL House, Putney,
T London, SW15 1SW, England
Circle 650

ID SYSTEMS CORP.
T 4093 Leap Rd.
Hilliard, OH 43026
(614) 876-1595
Circle 651

IMLAC CORP.
T 150 A St., New England Industrial Park
Needham, MA 02194
(617) 449-4600
Circle 652

INDUSTRIAL DATA TERMINALS CORP.
T 173 Heatherdown Dr.
Westerville, OH 43081
(614) 882-3282
Circle No 653

INCOTERM CORP.
D 65 Walnut St.
Wellesley Hills, MA 02181
Circle 654

INFORMER, INC.
T 8332 Osage Ave.
Los Angeles, CA 90045
(213) 649-2030
Circle 655

INFOSCRIBE, INC.
P 2720 S. Croddy Way
Santa Ana, CA 92704
(714) 641-8595
Circle 656

INNOTRONICS CORP.
D Brooks Rd.
Lincoln, MA 01773
(617) 259-0600
Circle 657

INTEGRATED DATA SYSTEMS, INC.
T 3005 E. Main St.
Waterbury, CT 06705
(203) 573-1795
Circle 659

INTEGRATED TERMINALS, INC.
T 4132 Billy Mitchell Rd.,
Addison, TX 75001
(214) 233-6631
Circle 660

INTEGRAL DATA SYSTEMS, INC.
P Route 13 South
Milford, NH 03055
(603) 673-9100
Circle 661

INTELLIGENT SYSTEMS CORP.
T 225 Technology Park
Norcross, GA 30092
(404) 499-5961
Circle 662

INTERFACE SYSTEMS INC.
P 462 Jackson Plaza
Ann Arbor, MI 48103
(313) 769-5900
Circle 663

INTERFACE TECHNOLOGY, INC.
T 10500 Kahlmeyer Dr.
St. Louis, MO 63132
(314) 426-6880
Circle 664

INTERNATIONAL ENTRY SYSTEMS, INC.
T 408 NE 72nd St.
Seattle, WA 98115
(206) 525-6800
Circle 665

INTERNATIONAL MICROTRONICS CORP.
P 4016 E. Tennessee St.
Tucson, AZ 85714
(602) 748-7900
Circle 666

INTERTEC DATA SYSTEMS CORP.
T 2300 Broad River Rd.
Columbia, SC 29210
(803) 798-9100
Circle 667

IOMEGA CORP.
D 4646 S. 1500 W.
Odgen, UT 84403
(801) 392-7581
Circle 668

IRWIN OLIVETTI
P 2000 Green Rd.
D Ann Arbor, MI 48105
(313) 663-3600
Circle 669

ISOTIMPEX
D 51 Chapaev St.
Sofia, Bulgaria
Circle 670

ISS/SPERRY UNIVAC CORP.
D 3333 Scott Blvd.
Santa Clara, CA 95051
(408) 496-3333
Circle 671

ITT COURIER
T 1515 W. 14th St.
Tempe, AZ 82581
(602) 894-7000
Circle 672

KENNEDY CO.
D 1600 S. Shamrock Ave.
Monrovia, CA 91016
(213) 357-8831
Circle 673

KIMTRON CORP.
T 2255-I Martin Ave.
Santa Clara, CA 95050
(408) 727-1510
Circle 674

KONTRON ELECTRONICS, INC.
P 630 Prince Ave.
Redwood City, CA 94063
(415) 361-1012
Circle 675

LANPAR TECHNOLOGIES, INC.
T 85 Torbay Rd.
Markham, Ontario, Canada
CD L3R 167
(416) 475-9123
Circle 676

LEAR SIEGLER, INC.
P 714 N. Brookhurst St.
T Anaheim, CA 92803
(714) 774-1010
Circle 677

LEE DATA CORP.
T 10206 Crosstown Circle
Eden Prairie, MN 55344
(612) 932-0300
Circle 678

LEXICON CORP.
T 60 Turner St.
Waltham, MA 02154
(617) 891-6790
Circle 679

LIBERTY ELECTRONICS
T 100 Clement St.
San Francisco, CA 94118
(415) 751-7560
Circle 680

LITTON INDUSTRIES, INC.
P Westrex OEM Products Div.
1140 Bloomfield Ave.
West Caldwell, NJ 07006
(201) 227-7290
Circle 681

LOBO DRIVES INTERNATIONAL
D 358 S. Fairview Ave.
Goleta, CA 93117
(805) 683-1576
Circle 682

LOGIC SYSTEMS, INTERNATIONAL
D Moriden Bldg. 9-9, Mita 3-chome
Minato-ku, Tokyo 108, Japan
Circle 683

LOGICON-INTERCOMP, INC.
D 21535 Hawthrone Blvd., Suite 440
T Torrance, CA 90503
(213) 373-0220
Circle 684

LYNWOOD SCIENTIFIC DEVELOPMENTS
T Caker Stream Rd., Mill Lane
Alton, Hants, GU34 20F
England 84888
Circle 685

MALIBU ELECTRONICS CORP.
P 2301 Townsgate Rd.
Westlake Village, CA 91361
(805) 496-1990
Circle 686

MANNESMAN TALLY, INC.
P 8301 S. 180th St.
Kent, WA 98031
(206) 251-5524
Circle 687

MATCHLESS SYSTEMS
P 18444 S. Broadway
D Gardena, CA 90248
(213) 327-1010
Circle 688

MATROX ELECTRONIC SYSTEMS, LTD.
T 5800 Andover Ave.
T.M.R. Quebec,
H4T 1H4, Canada
(514) 735-1182
Circle 689

MATSUSHITA CO., LTD.
D 4-3-1 Tsunahima-Higashi
Hokoku-ku, Yokohama 223, Japan
(045) 531-1231
Circle 690

MDS TRIVEX
T 3180 Red Hill Ave.
Costa Mesa, CA 92626
(714) 546-7781
Circle 691

MEGADATA CORP.
T 35 Orville Dr.
Bohemia, NY 11716
(516) 589-6800
Circle 692

MEGATEK CORP.
T 3985 Sorrento Valley Blvd.
San Diego, CA 92121
(714) 455-5590
Circle 693

MEGAVAULT
D 6431 Independence Ave.
Woodland Hills, CA 91367
(213) 884-7300
Circle 694

MEMODYNE CORP.
D 220 Reservoir St.
Needham Heights, MA 02194
(617) 444-7000
Circle 695

MEMOREX CORP.
P San Tomas and Central Expwy.
D Santa Clara, CA 95052
T (408) 987-1000
Circle 696

MEMOREX COMMUNICATIONS GROUP
D 18922 Forge Dr.
Cupertino, CA 95014
(408) 996-9000
Circle 697

MEPCOM INTERNATONAL, INC.
P 15181 Business Ave.
Dallas, TX 75234
(214) 484-0640
Circle 698

MERA/METRONEX
D Al. Jerozolimskie 44, Warszasa
Poland, 26-22-21
Circle 699

MICON INDUSTRIES
T 252 Oak St.
Oakland, CA 94607
Circle 700

MICRO PERIPHERALS, INC.
P 9754 Deering Ave.
D Chatsworth, CA 91311
(213) 991-0830
Circle 701

MICRO-SCI
D 2158 S. Hathaway St.
Santa Ana, CA 92705
(714) 662-2801
Circle 702

MICRO-TERM, INC.
T 1314 Hanley Industrial Court
St. Louis, MO 63144
(314) 968-8151
Circle 703

MICROCOMPUTER SYSTEMS CORP.
(see UNITED PERIPHERALS)

MICRODATA
T P.O. Box 19501
Irvine, CA 92713
(714) 540-6730
Circle 704

MICROPAD, INC.
T 5650 S. Brainard Ave.,Suite 212
La Grange, IL 60525
(313) 579-3200
Circle 705

MICROPOLIS CORP.
D 21329 Nordhoff St.
Chatsworth, CA 92311
(213) 709-3300
Circle 706

MICROTEK, INC.
P 9514 Chesapeake Dr.
San Diego, CA 92123
(714) 278-0633
Circle 707

MILLADYNE
P 60 Plant Ave.
Hauppage, NY 11788
(516) 582-6060
Circle 708

MILTOPE CORP.
P 1770 Walt Whitman Rd.
T Melville, NY 11747
(516) 420-0200
Circle 709

MINI-COMPUTER SYSTEMS, INC.
T 399 Fairview Park Dr.
Elmsford, NY 10523
(914) 592-8812
Circle 710

MINISCRIBE CORP.
D 410 S. Sunset St.
Longmont, CO 80501
(303) 651-6000
Circle 711

MITSUBISHI ELEC. CORP.
D 2200 W. Artesia Blvd.
Compton, CA 90220
(213) 637-6246
Circle 712

MOHAWK DATA SCIENCE CORP.
P Seven Century Dr.
D Parsippany, NJ 07054
T (201) 540-9080
Circle 713

MORROW DESIGNS INC.
D 5221 Central Ave.
Richmond, CA 94804
(415) 524-2101
Circle 714

MOTOROLA SEMICONDUCTOR PRODUCTS, INC.
P P O. Box 20912
Phoenix, AZ 85036
(602) 244-6900
Circle 715

MQI COMPUTER PRODUCTS
(see EPIC)

MSI DATA CORP.
T 340 Fischer Ave.
Costa Mesa, CA 92626
(714) 549-6000
Circle 716

MULTITECH INDUSTRIAL CORP.
T 977 Min Shen E. Rd., Taipei
105 Taiwan R.O.C.
02-7691225
Circle 717

MYLEE DIGITAL SCIENCES, INC.
D 155 Weldon Pkwy.
T Maryland Heights, MO 63043
(314) 567-3420
Circle 718

N.V. PHILIPS-ELECTROLOGICA
D P.O. Box 523, 5600 AM
Eindhoven, Netherlands
Circle 719

NABU COMMERICAL TERMINALS
T 330 Weber St. N.
Waterloo, Ontario, Canada
N2J 3H6
(519) 884-9300
Circle 720

NATIONAL DATA PRODUCTS
P 1 Tall Timber Rd.
Middletown, NJ 07748
Circle 721

NATIONAL MEMORY SYSTEMS CORP.
D 721 Mayview
Livermore, CA 94550
(415) 443-1669
Circle 722

NCR CORP.
P 1700 S. Patterson Blvd.
D Dayton, OH 45479
T (513) 445-5000
Circle 723

NEC INFORMATION SYSTEMS, INC.
P 5 Militia Dr.
D Lexington, MA 02173
(617) 862-3120
Circle 724

NETCOM PRODUCTS, INC.
T 430 Toyama Dr.
Sunnyvale, CA 94086
(408) 734-8732
Circle 725

NEW WORLD COMPUTER CO., INC.
D 1805 McGaw Ave.
Irvine, CA 92714
(714) 556-9320
Circle 726

NIPPON ELECTRIC INDUSTRY CO., LTD.
D No. 19-18, 1-chome, Tsutsumi-Dori
Sumida-ku, Tokyo, Japan
(03) 613-1111
Circle 727

NIPPON PERIPHERALS, LTD.
D 825 3rd Ave.
New York, NY 10022
(212) 758-7020
Circle 728

NORAND CORP.
T 550 Second St., SE
Cedar Rapids, IA 52401
(319) 366-7611
Circle 729

NORDATA
D 4433 27th Ave., W.
Seattle, WA 98199
(206) 282-1170
Circle 730

NORDEN SYSTEMS
D Norden Place
Norwalk, CT 06856
(203) 852-4908
Circle 731

NORSK DATA, AS
D P.O. Box 163 Okern
T Oslo 5, Norway
Circle 732

NORTHERN TELECOM SYSTEMS CORP.
D P.O. Box 1222
T Minneapolis, MN 55440
(612) 932-8085
Circle 733

NOVELL DATA SYSTEMS, INC.
P 1170 N. Industrial Park Dr.
T Orem, UT 84057
(801) 226-8202
Circle 734

OHIO SCIENTIFIC MEMORY PRODUCTS, INC.
D 849 Ward Dr.
Santa Barbara, CA 93111
(805) 964-3535
Circle 735

OKI ELECTRIC INDUSTRY CO., LTD.
D 1-17-12, Toranomon
Minato-ku, Tokyo 105, Japan
(03) 501-3111
Circle 736

OKIDATA CORP.
P 111 Gaither Dr.
D Mount Laurel, NJ 08054
(609) 235-2600
Circle 737

ONTEL CORP.
T 250 Crossways Park Dr.
Woodbury, NY 11797
(516) 364-2121
Circle 738

OTTO ELECTRONICS
T P.O. Box 3066
Princeton, NJ 08540
(609) 448-9165
Circle 739

PANASONIC CORP.
P 1 Panasonic Way
Secaucus, NJ 07094
(201) 348-5336
Circle 740

PARADYNE CORP.
T 8550 Ulmerton Rd.
Largo, FL 33540
(813) 530-2222
Circle 741

PARASITIC ENGINEERING, INC.
D 1101 Ninth Ave.
Oakland, CA 94606
(415) 839-2636
Circle 742

PERSCI, INC.
D 12210 Nebraska Ave.
W. Los Angeles, CA 90025
(213) 820-7613
Circle 743

PERCOM DATA CO., INC.
D 11220 Page Mill Rd.
Dallas, TX 75243
(214) 340-7081
Circle 744

PERKIN-ELMER DATA SYSTEMS CORP.
P 2 Crescent Place
D Oceanport, NJ 07757
T (201) 870-4500
Circle 745

PERRY DATA SYSTEMS, INC.
T 3401 Spring Forest Rd.
Raleigh, NC 27605
(919) 876-8100
Circle 746

PERTEC COMPUTER CORP.
P 17332 Von Karman Ave.
D Irvine, CA 92714
T (714) 540-8340
Circle 747

PHILIPS DATA SYSTEMS
D Postbus 245, 7300 AE Apeldoorn
Appeldorn, The Netherlands
(055) 330123
Circle 748

PIICEON, INC.
T 2045 Lundy Ave.
San Jose, CA 95131
(408) 946-8030
Circle 749

PLESSEY PERIPHERAL SYSTEMS
D 17466 Daimler
T Irvine, CA 92714
(714) 540-9945
Circle 750

POLYMORPHIC SYSTEMS
D 5730 Thornwood Dr.
Santa Barbara, CA 93117
(805) 967-0468
Circle 751

POTTER INSTRUMENT CO., INC.
P 10 Main St.
Gonic, NH 03867
(603) 332-1991
Circle 752

PRACTICAL AUTOMATION, INC.
P P.O. Box 313
Shelton, CT 06484
(203) 929-5381
Circle 753

PRIAM CORP.
D 20 W. Montague Expwy.
San Jose, CA 95134
(408) 946-4600
Circle 754

PRIME COMPUTER, INC.
T Prime Park
Natick, MA 01760
(617) 655-8000
Circle 755

PRINTACOLOR CORP.
P 5965 Peachtree Corners E.
Norcross, GA 30071
(404) 448-2675
Circle 756

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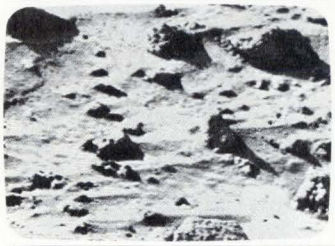
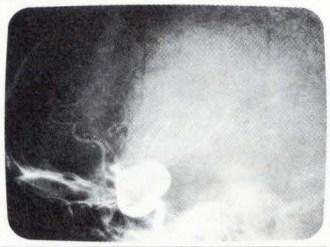
CONRAC SERIES 2400

The benchmark in high-resolution monochrome

The new benchmark in monochrome CRT displays comes from Conrac—our 2400 high-resolution monitor. Advanced electronics and tube technology combine to give you a fine spot size, wide video bandwidth, and high horizontal scanning frequency. The result: a bright and crisp 1280 x 960 pixel raster-scan display.





Ultimate clarity and illumination.
No matter where you measure on the screen, the 2400 offers a .35 mm spot size, and the light intensity of each spot has been increased by nearly 50%.

Dynamic focusing circuitry and special beam focusing construction enable this exceptional spot performance.

Wide video bandwidth.
Video bandwidth of the 2400 is a broad 40 MHz (−3dB), allowing more information on the screen while providing the rapid rise and fall times needed for crisp pixel definition. You get all the performance you built into your system, while users appreciate the sharp, clear image.

Selectable scan frequencies.
This convenient option can cut your inventory while giving you a new range of flexibility. Now, you can buy and stock one monitor for horizontal scanning frequencies from 15 kHz to 37 kHz, enabling compatibility with a range of systems.

And the system user gets a monitor that can be upgraded by the simple change of a switch, instead of replacing the monitor.

New versatility in applications.
The high-resolution 2400 is available in cabinet, rack-slide or chassis-only configurations—either 13″ or 19″ CRT. The 19″ offers 1280 horizontal x 960 vertical pixel resolution at a 1225-line rate, and the 13″ offers 1024 x 768 pixel resolution.

Every graphics system will look better, and offer less user fatigue, whether the system is for industrial CAD/CAM or tight VLSI circuit design. And medical electronics displays have a clarity and crispness not seen before, especially if a wide gray scale is desired.

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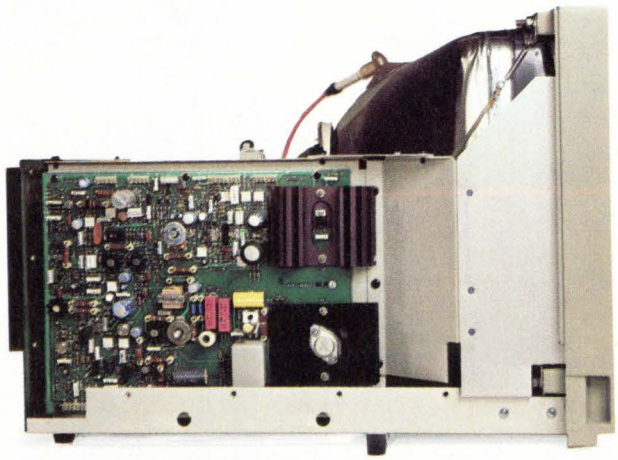
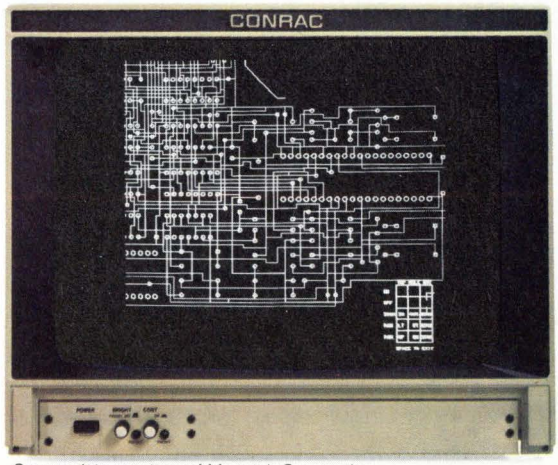
See us at the National Computer Graphics Association (NCGA) Show in Anaheim, California, June 15-18. Also see us at Siggraph in Boston, July 26-30.

CONRAC





Screen data courtesy of Megatek Corporation.

CIRCLE NO. 185 ON INQUIRY CARD

"A distributed data base from micros to mainframes?"

Now you can have a relational data base for your microcomputer that's transportable to minis and large scale computers right up to the IBM 370 and Cray mainframes. MicroRIM Data Base Management Software makes it unnecessary to re-define the data base files when transferring them from one computer to another. So, instead of working on programming details, users are free to concentrate on the data itself.

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MicroRIM evolved from the mainframe version of RIM, first used in the NASA Space Shuttle Program. Today, it is being used extensively for business, industry, and research. To learn more, write MicroRIM, P.O. Box 585, Bellevue, Wa. 98009, or call (206) 453-6017. We'll show you how easy it is to get more from your microcomputers.

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CIRCLE NO. 186 ON INQUIRY CARD

Low-cost system includes disk drive, smart terminal

Morrow Designs, Richmond, Calif., has introduced a business and personal computer with a floppy disk drive and a CRT terminal that sells for $1790—less than the claimed value of the software included with the system.

The Micro Decision, an 8-bit microcomputer based on the 4-MHz Z80A CPU, includes 64K bytes of RAM, two RS232 ports, a full-sized terminal with detachable keyboard and a single-sided, 5¼-in. floppy disk drive that stores 200K bytes (formatted). A second floppy disk drive, priced at $350, is optional.

The Micro Decision uses CP/M 2.2. Other software included is Microsoft BASIC 80, BaZic (compatible with NorthStar BASIC), WordStar word-processing software, the Correct-It spelling checker and the LogiCalc electronic spread sheet.

The Micro Decision is for small-business customers that need a first-time system that is user friendly. The system features a menu-driven front-end program that provides a road map through CP/M, which can be deactivated when a user is familiar with the commands.

Morrow Designs' Micro Decision, *a small-business/personal-computer system with floppy disk drive, CRT terminal and industry-standard software, sells for less than $1800.*

An enhanced BIOS reads and writes multiple diskette formats including IBM, Osborne and Xerox 820 formats. A virtual drive feature—useful in single-drive systems—reassigns to drive A any reference to a nonexisting drive, prompting the user with a screen message when a diskette change is necessary. After the user specifies terminal type at installation, the BIOS automatically configures the supplied software programs to match that terminal's protocol. Automatic diagnostics and part of the BIOS are located on system EPROM, leaving maximum RAM space for application programs.

Future plans calls for incorporation of Winchester drives as well as a networking capability that will allow the Micro Decision to be plugged into the vendor's larger multi-user system, the Decision I. **Morrow Designs,** 5221 Central Ave., Richmond, Calif. 94804. **Circle No 300**

STD-bus-compatible boards operate at extended temperatures

Wintech Systems, Inc., has introduced two STD-bus-compatible CMOS product lines for extended-temperature and low-power operation. The MCM series Z80-based microcomputer boards operate at −40° to +85°C. The MCM-CPU contains a Z80 microprocessor, 8-byte-wide memory sockets and a programmable reset address. It is available in 2.5- or 4-MHz clock speeds. The MCM-PI01 and MCM-PI02 are parallel I/O boards that have 64 lines of I/O in different configurations of input and output ports. The MCM-SPI/0 serial-parallel I/O board has 32 lines of parallel I/O and one asynchronous, RS232C or opto-isolated current-loop interface, serial I/O port with selectable baud rates of 50 to 19.2K bps. The MCM-PI01, MCM-PI02 and MCM-SPI/0 operate at clock speeds as high as 4 MHz.

We Asked UNIX* Users What They Wanted in an Integrated Workstation. Here's What They Said...

1. "We want a full Bell Labs UNIX operating system — not a look alike."

UNISTAR™ 100 is just that. It runs on an eight MHz, 68000, 16/32 bit CPU with 256K bytes of local memory, expandable to 1M bytes. UNISTAR provides the ultimate in cost-effective, versatile computing power for professionals.

2. "Give us a wide selection of languages."

UNISTAR 100 comes with C and 68000 ASM, with Pascal, COBOL, Fortran 77 and BASIC as options.

3. "We need plenty of disk storage."

An integral 5¼-inch, 10M byte Winchester and 5¼-inch, 0.6M byte floppy is standard, with additional 21M byte Winchester capacity to be available.

4. "We'd like room for additional options."

UNISTAR 100 has a built-in, six slot Multibus* card cage. It also has two, two RS-423 multiprotocol serial ports and a parallel 16-bit input/output port, too.

Another product of Callan Engineering and Manufacturing Excellence

5. "Give us a CPU that will take full advantage of fast memory chips."

UNISTAR 100 has advanced CPU board design with 256K bytes of on-board memory, together with a unique two-level, segment paged, multiprocess memory management scheme that eliminates CPU/MMU wait cycles, provides a timed-integer computational rate of 40% to 50% of a 11/780.

6. "We feel it's important to be Ethernet* -compatible."

UNISTAR 100 enhancements include an Ethernet interface controller, with UNIX-based UNET* software.

7. "If possible, we'd like all of this in a single, attractive package."

You've got it! UNISTAR 100 has packaged all of your needs — and more — in a desktop workstation with a detachable keyboard.

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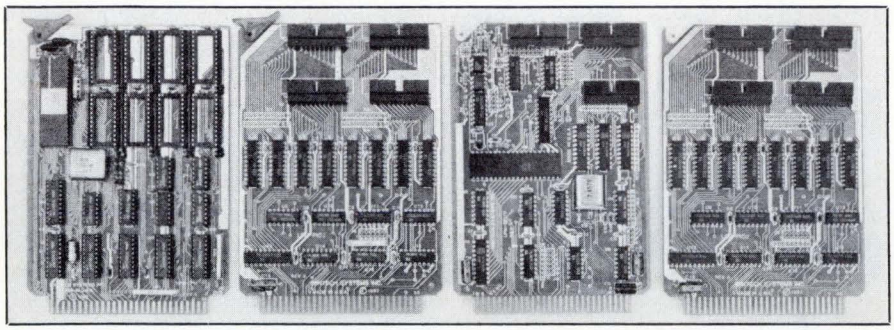
CIRCLE NO. 188 ON INQUIRY CARD

See us at COMDEX Booth 3342.

The LPM series microcomputer boards are designed with CMOS for low-power operation and, like the MCM series boards, are designed to operate at −40° to +85°C. The LPM-CPU board consists of a 1-MHz NSC-800 (software compatible with the Z80), eight-byte-wide memory sockets and features a power-save operating mode for low-power standby. The other boards in the LPM series, LPM-PI01, LPM-PI02 and LPM-SPI/0 are similar in function to the MCM boards with the same designations, but are designed and built with CMOS and operate at 1 MHz.



Wintech Systems, Inc.'s MCM and LPM series STD-bus compatible CMOS boards *are designed for extended-termperature and low-power operation. They are built with burned-in components and are burned in a second time for 48 hours before shipment.*

All MCM and LPM series boards are available with conformal coating for harsh environments.

In 25- to 49-unit quantities, the MCM series boards are priced at $371 for the MCM-CPU, $296 for the MCM-PI01 and MCM-PI02 boards and $356 for the MCM-SPI/0. In similar quantities, the LPM series boards are priced at $431 for the LPM-CPU, $356 for the LPM-PI01 and LPM-PI02 boards and $394 for the LPM-SPI/0. **Wintech Systems, Inc.,** Box 121361, Arlington, Texas 76012. **Circle No** 301

Columbia introduces 16-bit IBM PC-compatible computer

The 16-bit Multi-Personal Computer, a hardware- and software-compatible replacement for the IBM Personal Computer, supports single- and multi-user configurations for personal, business, industrial and scientific applications.

The basic MPC model 1600-1, priced at $2995, has a 16-bit 8088 processor, 128K RAM with parity, two RS232 ports, a Centronics parallel printer port, an interrupt/DMA controller, a counter/timer, dual floppy disk drives with 640K bytes of storage, Winchester disk and keyboard interfaces and eight IBM PC-compatible expansion ports.

The models 1600-2 and 1600-3 are Winchester disk configurations that have one 320K-byte floppy disk drive and one 5M- or 10M-byte hard disk drive. The units feature a cache buffer hard disk controller with an independent 64K-byte processor system. They are priced at $4995 and $5495, respectively.

The Multi-Personal Computer supports RS232 video display terminals for single-and multi-user applications. In single-user applications only, it supports black-and-white or color CRT monitors and IBM PC-compatible keyboards.

Columbia Data Products' Multi-Personal Computer *uses software and hardware originally intended for the IBM PC.*

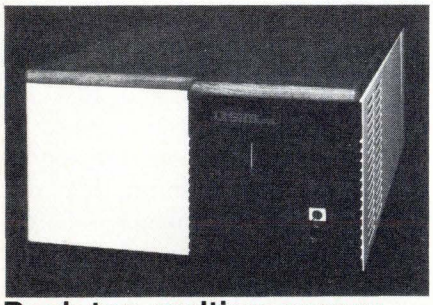
Hardware-expansion options include RS232 communications boards, expansion memory boards, a black-and-white and color display controller, a Z80 CP/M 80 board, a time/calendar board, an 8087 mathematical processor, an IEEE controller bus, CRT monitors and a keyboard. Optional 8-in. floppy and hard disk drives and a tape-cartridge system increase the MPC's storage capacity.

Operating-system software includes single-user MS/DOS or CP/M 86 or multi-user, multitasking MP/M 86 or OASIS 16. CP/M 80 is also supported with an optional Z80 CP/M board. High-level languages including BASIC, FORTRAN, Pascal, COBOL and Macro Assembler are available. **Columbia Data Products, Inc.,** 8900 Route 108, Columbia, Md. 21045. **Circle No** 302

Systems

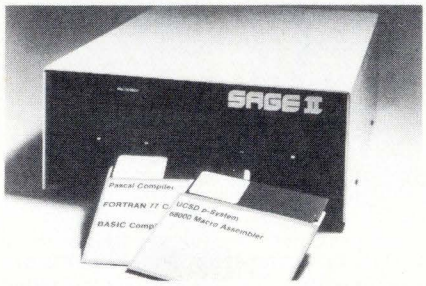
Single-board micro is expandable

The System-5 single-board microcomputer, based on the Z80A microprocessor, has 64K bytes of high-speed dynamic RAM with parity checking, optionally expandable to 320K bytes in 64K-byte increments. The system also features phantom ROM and optional color video graphics, and is available with single- or double-sided, single- or dual-density, 5¼-in. floppy disk drives. System-5 includes CP/M and application software for word processing, accounting and database management. It also includes networking, with 32 nodes providing system-network resource sharing via EXO/NET. System-5 is also available with CP/M's multi-user option, MP/M. Prices start at $2495. **EXO Corp.,** 1265 Montecito Ave., Mountain View, Calif. 94043. **Circle No** 303



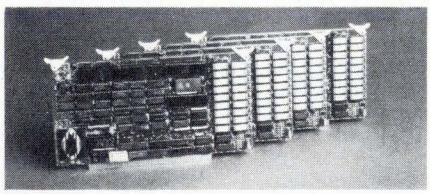
Desk-top multiprocessor accommodates eight users

The Zeus3 desk-top, multi-user multiprocessor operates in an environment that is expandable from two to eight users, with each user having a terminal and dedicated printer or with as many as three shared master printers. The Zeus3 uses the vendor's CP/M-compatible MUSE (multi-user system executive) operating system and is S-100 compatible. A standard two-user configuration, priced at $7995, consists of a 5¼-in. Winchester disk that stores 12M bytes (unformatted), a 5¼-in. floppy disk drive, a master CPU and two user boards. Each user board has a Z80A microprocessor that operates at 4 MHz, 64K bytes of RAM, two serial I/O ports and one parallel I/O port. Options include a 20M-byte streaming tape drive or an 8-in. floppy disk subsystem. **OSM Computer Corp.,** 2364 Walsh Ave., Santa Clara, Calif. 95051. **Circle No** 304



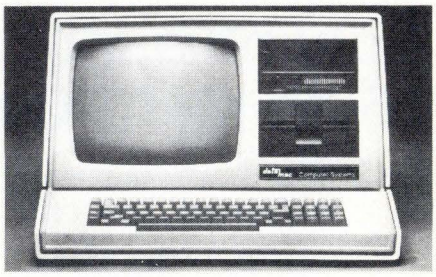
Micro features UCSD p-System

The Sage II microcomputer now includes the UCSD p-System version 4.1 as standard at no additional cost. The operating system features Pascal, FORTRAN 77 and BASIC compilers, as well as a 68000 macro assembler, an extended memory feature, a print spooler, a file handler, line- and screen-oriented editors, a linker and utility programs. The Sage II 8-MHz, 68000, 16-bit microcomputer includes a built-in 320K-byte drive, 128K bytes of RAM and the p-System. Disk capacity can be optionally increased to 1.3M bytes, and RAM capacity can be increased to 512K bytes. The Sage II is priced at $3600. **Sage Computer Technology,** 195 N. Edison Way, Suite 14, Reno, Nev. 89502. **Circle No** 305



Processor provides CPU for each user

The Super-Slave processor provides a dedicated CPU for every user in a multi-user environment without limiting system size. Designed to fit in any S-100 motherboard, the Super-Slave board includes a Z80A CPU, four serial and two parallel I/O ports, 2K bytes of EPROM (expandable to 4K bytes) and 64K bytes of bank-switched RAM (expandable to 128K bytes). Each Super-Slave board is linked through the S-100 bus to a master board such as the vendor's Super-Quad single-board computer. The Super-Slave shares data with its host only when accessing the drives or other common peripherals, so additional users cause almost no degradation in system time. Price is $650. **Advanced Microdigital Corp.,** 12700 B Knott Ave., Garden Grove, Calif. 92641. **Circle No** 306



Micro has optional 5¼-in. Winchester disk

The Series 800 CP/M-based desk-top computer system includes a Z80 processor, 64K bytes of RAM, two RS232 I/O ports, one parallel port and a streamlined chassis and CRT with detached keyboard. The Series 800 can accommodate floppy and hard disk drives in a variety of configurations: single- or double-density, 5¼- or 8-in. floppies (single- or double-sided) and 5¼-in., 6M-, 12M- or 18M-byte Winchester disks. The system supports BASIC, FORTRAN, COBOL, Pascal, FORTH, macroassembler and business and word-processing packages. Options include a full screen editor and a hardware-based system activity monitor that displays or alters memory and registers. The System

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			common-mode	transverse mode		
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Dedicated Line (with dedicated ground)	some, internal only	some, internal only	some, internal only	some, internal only	No	No
Ultra-Isolation Transformer	No	No	Yes	No	No	No
Sola Micro-Minicomputer Regulator	Yes	Yes	Yes	Yes	Yes	No
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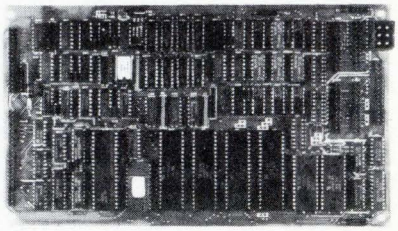
800 also features Corvus networking, a multi-user capacity, intelligent-terminal emulation, multiple-disk formats, remote diagnostics, an optional EPROM burner and 12 programmable function keys. Prices range from $2650 to $6870, depending on configuration. **Datamac Computer Systems,** 680 Almanor Ave., Sunnyvale, Calif. 94086. **Circle No** 307

16-bit micro operates at 10 MHz

The E-1 single- or multi-user microcomputer, based on an 8086-1 microprocessor, operates at 10 MHz with no wait states. The MP/M 86-based, 16-bit microcomputer operates as many as 10 workstations. A minimally configured four-user system, priced at $5995, includes a 512K dynamic RAM with National Semiconductor's 8409-2 chip and two 8-in., single-sided, double-density floppy disk drives with a total formatted capacity of more than 1M byte. Options include a 30M-byte, 14-in. hard disk drive that can be mounted within the system's enclosure, a streaming-tape cartridge drive, double-sided, double-density, 8-in. floppy disk drives and a desk enclosure. **Euclid Computer,** 3699 W. 240th St., Torrance, Calif. 90505. **Circle No** 308

Z80 board fits in 5¼-in. drive enclosure

The DSB-4/6 single-board microcomputer has a 4-MHz Z80A or 6-MHz Z80B CPU and measures 10 × 5¾ × ¾ in. It has 64K bytes of RAM, a 2K-byte EPROM for start-up, a BIOS for CP/M utilities and a disk



controller that automatically interfaces with both 5¼- and 8-in. drives simultaneously in single- or double-density recording format. The system includes a Centronics parallel printer port and a second parallel port for interfacing hard disks. As many as three serial I/O ports are available for standard peripherals, with a fourth port configured for a modem. For single-unit orders, the DSB-4/6 is priced from $695 to $995, depending on CPU and the number of I/O ports. Quantity discounts are available. **Davidge Corp.,** 1951 Colony St., Suite X, Mountain View, Calif. 94943. **Circle No** 309

Desk-top computer has 40M-byte capacity

The Masterkey 230I desk-top business computer incorporates an 8-in., 40M-byte Winchester disk drive and a 400K-byte, 8-in. floppy disk drive. Its dual-processor architecture uses the 2-MHz 6502 and the 4-MHz Z80 processors. The system includes 56K bytes of RAM and, through the installation of one memory board per user, can be expanded to as many as four time-sharing users. Two parallel (Centronics- and Diablo-compatible) and four serial I/O ports and one Keyring network port accommodate a variety of printers and CRT terminals. The system operates with the vendor's OS65U operating system that features integrated business BASIC. The unit is priced at $11,975. **M/A-Com Office Systems, Inc.,** 7 Oak Park, Bedford, Mass. 01730. **Circle No** 310

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Choose between Winchester systems or controllers

Complete systems to minimize system costs . . .
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- Choose 8.9Mb, 17.8Mb, or 35.6Mb of formatted Winchester disk storage.
- Up to 427K bytes/sec data transfer for Winchester and 63K bytes/sec for floppy.
- Supports IBM single and double density diskette formats plus DEC's RX01/ RX02 formats or INTEL 202 format depending on host computer.
- Single board interfaces are compatible with PDP-11 Unibus, LSI-11 Q-Bus, INTEL Multibus or use your own adapter card for special microcomputer busses.
- Convenient Winchester backup requires only 40 seconds per 1.2M byte floppy diskette.
- Off-line and on-line system and drive tests verify correct disk and controller operation.
- Automatic error retry, ECC (Error Correction Code) and Winchester disk flaw management insure exceptional data integrity.

Or just controllers to optimize system packaging.
All controllers used in SMS disk peripheral systems are available separately. Each controller supports (2) Shugart/Quantum Winchester and (2) Shugart floppy disk drives, utilizes patented PLL circuitry to provide maximum margins for worst case bit shifted data recovery, incorporates ECC (Error Correction Code) and includes on-board self test! Additional features are:

DEC PDP-11/LSI-11
- Single LSI-11 dual height or PDP-11 quad height interface plus formatter board.
- On board bootstrap and 22 bit Q-bus support.
- Standard RT-11, RSX-11M, UNIX,*** and SMS utility software support selective file backup and load operation.
- High performance data transfer of up to 427 bytes/sec.
- Emulates DEC RX02 floppy disk controller.
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INTEL MULTIBUS
- Single Multibus compatible PC board requires only 5A (max.) @ 5 volts.
- Direct connection to (2) Shugart/Quantum and (2) Shugart floppy disk drives. Eliminates external data separator board.
- Interface and command compatible with INTEL iSBC 215A and iSBX 218 controller boards.
- Supports IBM and INTEL iSBC 202 diskette formats.

GENERAL PURPOSE
- Single board controller requires only 5A (max). @ 5 volts.
- Interface, dimension and connector compatible with Shugart 1403D.
- Direct multi-sector disk transfer of up to 427K bytes/sec.
- Easy to use byte parallel general purpose interface.

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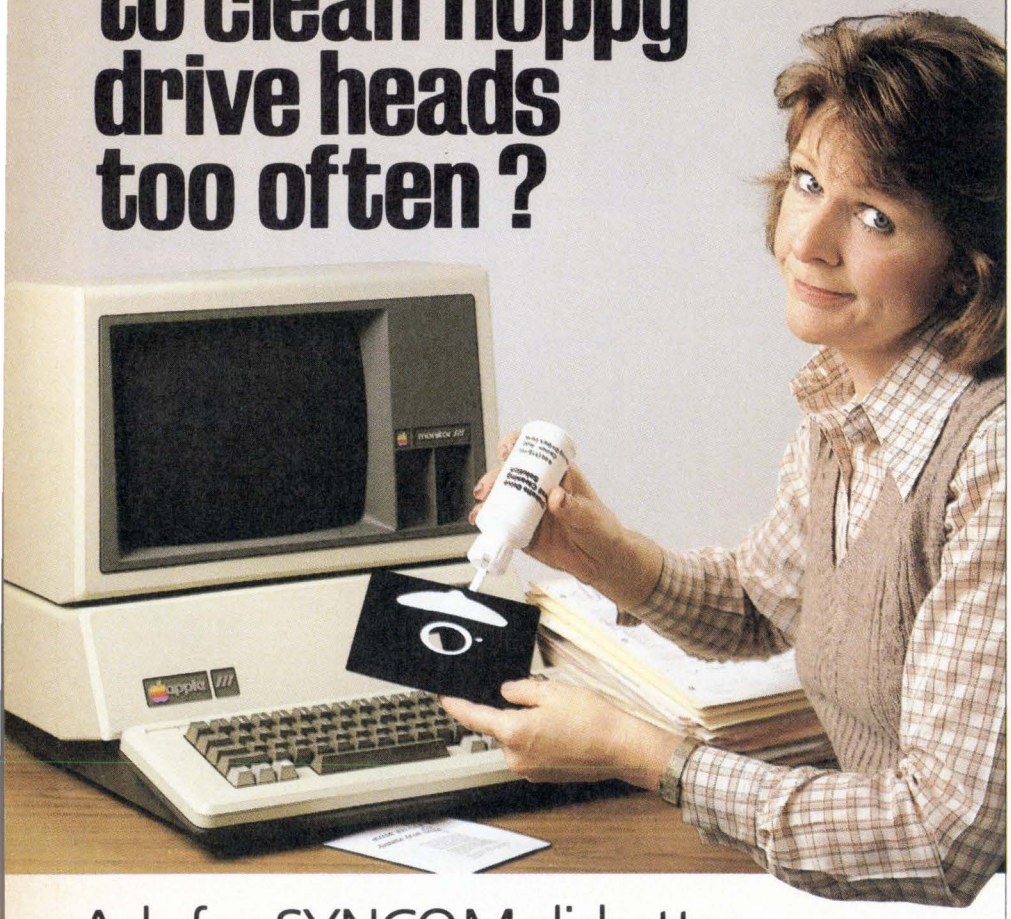

Ask for SYNCOM diskettes, with burnished Ectype® coating and dust-absorbing jacket liners.

As your floppy drive writes or reads, a Syncom diskette is working four ways to keep loose particles and dust from causing soft errors, dropouts.

Cleaning agents on the burnished surface of the Ectype®coating actually remove build-up from the head, while lubricating it at the same time.

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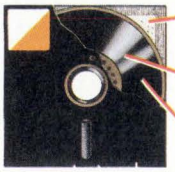
And the non-woven jacket liner, more than just wiping the surface, provides thousands of tiny pockets to keep what it collects.



To see which Syncom diskette will replace the ones you're using now, *send for our free "Flexi-Finder" selection guide* and the name of the supplier nearest you.

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Systems

Controller accommodates multiple array processors

The DPS-2460 dimensional processing system, a system-building tool for array-processor users, interfaces to a PDP or VAX computer and provides the control, memory and data transfer resources to keep multiple attached APs operating at full capacity. The DPS-2400 consists of peripheral device adapters, an internal bus structure and mass memory. Intelligent, microprocessor-based data interchange adapters interface the DPS to the host computer, the array processor, peripherals and other attached devices. The data interchange high-performance bus with full-duplex data lines and separate address lines has a 24M-bit-per-sec. bandwidth and supports simultaneous I/O of as many as eight APs, each transferring at their maximum 3M-bps rate. A 32-bit mass memory is accessible by each DIA. The DPS-2400 can be configured with as much as 24M bytes of memory accessible by the host, the DIAs, the APs and other devices in the DPS system. The DPS-2400 is supported by the STAPLE software package, which includes a high-level compiler/interpreter and a DPS Executive. A basic DPS-2400 configured with 2M bytes of mass memory and DIAs for the host, two array processors and two peripheral devices sells for approximately $65,000. DIAs are priced at $6500 each. **Aptec Computer Systems, Inc.,** 10180 S.W. Nimbus Ave., Portland, Ore. 97223. **Circle No** 311

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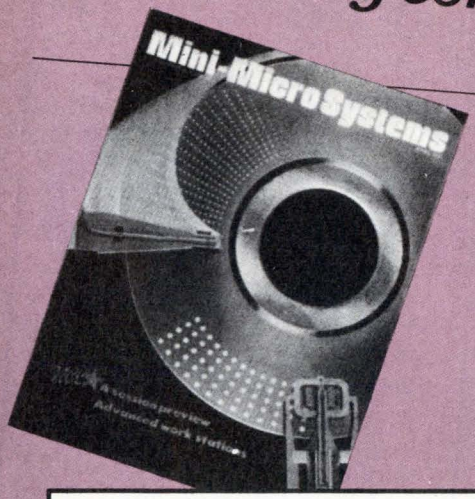

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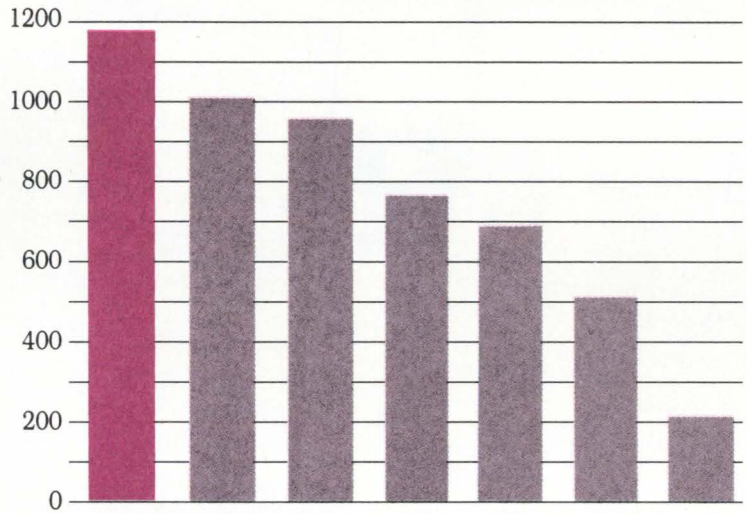

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Almost any word processing software package will have such features as menus, editing, spelling error detection, list processing, cut and paste, automatic word wrap and automatic pagination. . .

. . .**But** can you tell the difference between run-of-the-mill software and a system that is really special?

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THE QUESTIONS:

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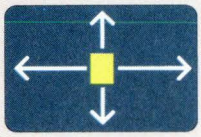


Which kind of editing operation is quickest to execute and easiest on the eyes of the word processing user?

a) Full screen editing allowing for easy cursor movement around the screen?

b) Moving the cursor around by doing a line count?

c) Editing on the bottom line of text only?

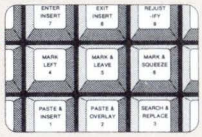
2 DOCUMENT LAYOUT

Whatever document format you choose. . .you want to see what the finished article will look like. Should you. . .

a) View it on the screen as it would come out of the printer?

b) Run it through a pre-processor to see what it looks like and then if you like it, print it?

3 KEYSTROKES



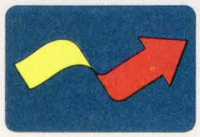
Using a well designed w-p system, how many keystrokes should it take to execute the most often used w-p functions?

a) One easy stroke with no codes?

b) Two or more with complex w-p codes?

c) Three or more?

4 FLEXIBILITY

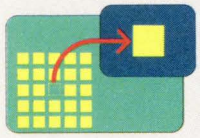


As the business manager of your company, you would like to find w-p software that you can tailor to your company's specific needs. Should you. . .

a) Look for w-p software that allows you to change and add menus, and change function keys?

b) Write your own custom software?

5 RETRIEVAL

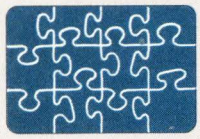


If you want to retrieve information quickly from a large database, which w-p software should you choose?

a) One that can access a particular record by going to it directly?

b) One that searches through all the records on the database sequentially until it finds the right one?

6 COMPATABILITY



As a manager of MIS, you want a w-p system that can be integrated with any other DEC compatible application software. Should you choose w-p software with. . .

a) ASCII formatted files?

b) Software which requires non-printing characters in it's file system?

7 MATH

Your company has a number of financial applications and is looking for a w-p package with math capabilities. Should you choose. . .

a) On screen calculating allowing for editing, storing and recall of equations, calculations integrated with your word processing applications?

b) Software where the math capabilities are tied to the list processing module?

c) A separate math package?

THE ANSWERS:

If you answered "a" to all of the questions above, go to the top of the class. Chances are that you already use **LEX-11** or are about to buy it. You know that **LEX-11** is the **ONLY** word processing software that combines these advanced features. . .and more. . . in one software package.

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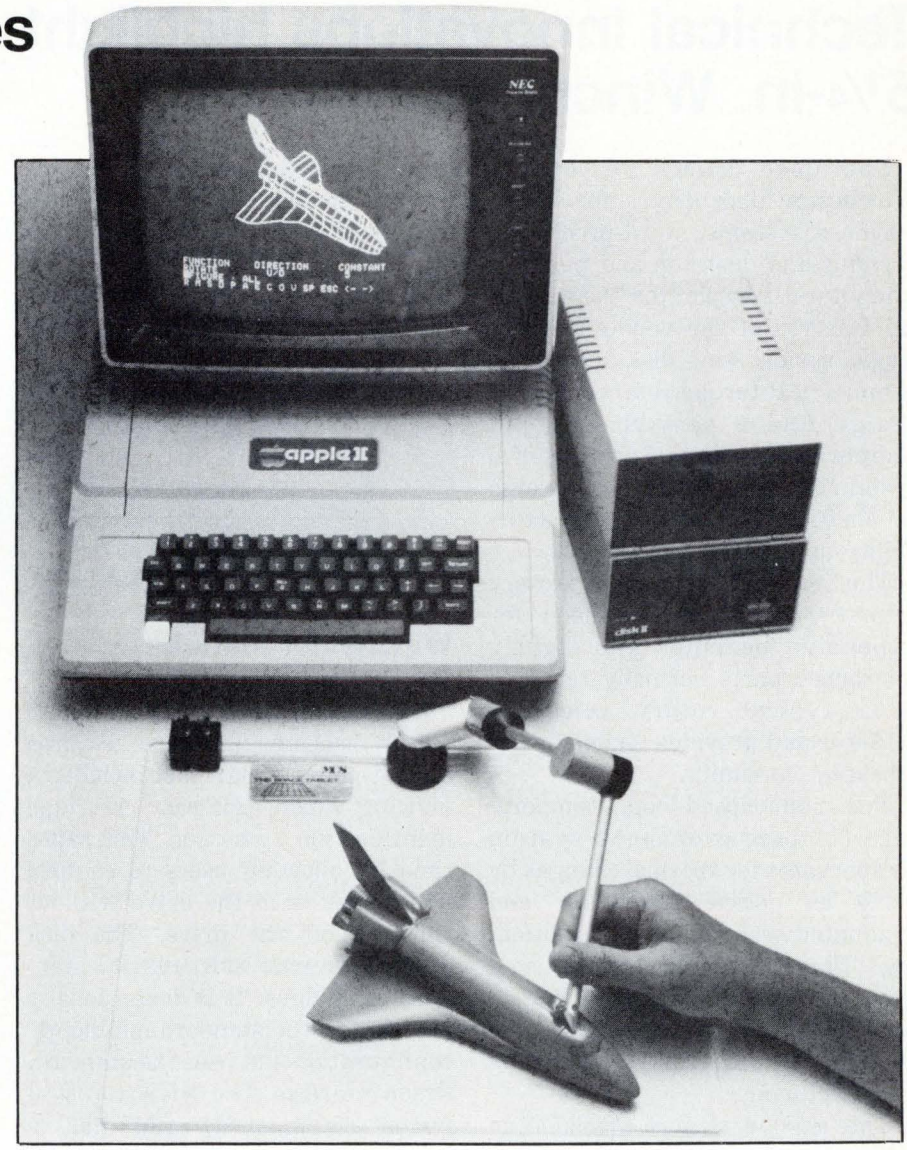
3D digitizer uses robot-like arm

The Space Tablet from Micro Control Systems, Vernon, Conn., is a 3D spatial digitizer compatible with the Apple Computer, Inc., Apple II and the IBM Corp. Personal Computer. It enables a user to record x, y and z coordinates of any object interactively by moving a pointer attached to a robot-like arm and pushing a button. With the software provided, a user can rotate and rescale drawings or compose one drawing from several components

The tablet consists of a precision machined aluminum and derlin arm mounted on a 13½- × 6-in. clear lucite tablet. Monitoring each axis of the arm is a precision potentiometer with a linearity of 0.5 percent. The resolution of each axis is approximately 1300 distinct states over an angle of 320 degrees. The arms operate in polar coordinates, and the sampling time is approximately 0.5 sec. per point.

When the data acquire button is pressed, the potentiometers in each joint record the three critical angles of the arm joints. This information is transformed into computer-readable space coordinates by an analog-to-digital converter provided by the host computer's game-paddle I/O port. The host computer determines the corresponding angle of each joint from the digital signal by using a look-up table. To increase the accuracy of the Space Tablet and to make it usable with a wider variety of computer systems, the vendor is developing a system that will have its own A/D converter and will plug directly into an RS232 interface.

Two models of the Space Tablet are available. The standard model, priced at $475, has three axes of rotation and is available only for the Apple II. The professional model, priced at $595, has a fourth axis of rotation that provides flexibility for reaching points in space. Either can be used as a 2D digitizer.



Micro Control System's Space Tablet 3D spatial digitizer *allows a user to record x, y and z coordinates of an object by moving a pointer attached to a robot-like arm.*

Software for the Space Tablet includes Space Graphics, a menu-driven system written in IBM Advanced BASIC. It features interactive 3D data acquisition; scaling, rotation and movement of drawings in three dimensions; interactive point editing; and hard copies produced on an optional MX-80 printer. The Complete Graphics System II user-oriented set of graphics programs for the Apple II offers features for the creation of multicolor graphic and text displays.

Applications include art, architecture, mechanical engineering, chemistry, education, computer peripheral and medical research. **Micro Control Systems, Inc.,** 143 Tunnel Rd., Vernon, Conn. 06066.

Circle No 312

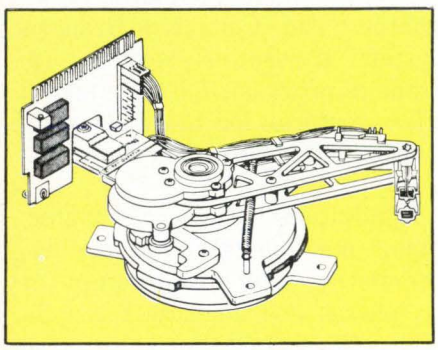
Technical innovations highlight 5¼-in. Winchester drives

The Q500 series of 5¼-in. Winchester disk drives for small-business systems, word-processing systems and desk-top and personal computers incorporates the technical features of the vendor's larger Q2000 series 8-in. disk drives. A symmetrical torque rotary actuator design and a semi-closed-loop, temperature-compensation servo system contribute to the Q500's high reliability, high-volume manufacturability and low cost.

The symmetrical torque rotary actuator eliminates the need for expensive bearings and tightly toleranced parts normally required in a typical rotary voice-coil actuator and provides for maximum vibration immunity.

The semi-closed-loop, temperature-compensation servo system compensates for thermal changes by using an optical transducer and graduated scale for coarse positioning. Fine positioning is achieved once per revolution from a prerecorded servo signal on the disk. The drive itself writes this signal during manufacturing.

The Q500 series is available in capacities of 10M, 20M, 30M and 40M bytes. Other features include 40- to 50-msec. average access times and a 5M-bit-per-sec. transfer rate. Volume production will begin in the first quarter of 1983, and prices will be announced. **Quantum Corp.,** 1804 McCarthy Blvd., Milpitas, Calif. 95035. **Circle No** 313



Quantum's Q500 series of Winchester disk drives *uses a symmetrical torque rotary actuator design.*

Winchester features front-panel window

The model WD505 5¼-in. removable Winchester disk drive features a front-panel design that includes a viewing window for easy cartridge identification by a user. This saves time by allowing users to confirm which disk is in the drive without shutting off the drive. The disk drive uses ANSI X3B7/1981-54 standard cartridges. It is dimensionally identical to the standard minifloppy configuration and uses the standard ST506 interface. The drive stores 5M bytes (formatted) and has a 35-msec. average access time and a 5M-bit-per-sec. data transfer rate. The WD505 is priced at $495 in single-unit quantities. **Western Dynex Corp.,** 3536 W. Osborn Rd., Phoenix, Ariz. 85019.

Circle No 314

Cartridge-tape drive operates at 60 ips

The HCD-75/60 cartridge-tape drive reads and writes at 60 ips, searches at 90 ips and transfers data at 35K bytes per sec. to provide backup for fixed-disk systems in the 30M- to 250M-byte range. Two preformatted, 16-track, 10,000-bpi, MFM cartridges for start/stop or modified streaming modes are available. The 600-ft. DC600HC cartridge stores 67M bytes, and the 150-ft. DC615HC cartridge stores 16.8M bytes. The system, with controller module, occupies 4.6 × 7 in. of panel space and is 19 in. deep. OEM prices in quantities of 100 are $874 each for drive modules, and $1406 for controller modules. **3M,** Department DR82-14, Box 33600, St. Paul, Minn. 55133.

Circle No 315

Subsystem for HP systems has Winchester floppy

The model 4895 disk subsystem for HP computers consists of a 5¼-in., fixed Winchester disk with a storage capacity of 4.72M bytes and an 8-in., double-sided, double-density floppy disk drive that stores 1.18M bytes. The hard disk has a transfer rate of 171K bytes per sec., and the floppy disk has a transfer rate of 46K bytes per sec. Average access times are 48.3 msec. and 174 msec., respectively. The subsystem emulates the HP 9895A protocol and is plug-compatible with all HP computers. Connection to the host computers is via a standard HP-IB interface without software or hardware changes. The system is priced at $6700. A 9.4M-byte Winchester configuration sells for $7700. OEM and volume discounts are available. **Bering Industries, Inc.,** 747 E. Brokaw Rd., San Jose, Calif. 95112.

Circle No 316

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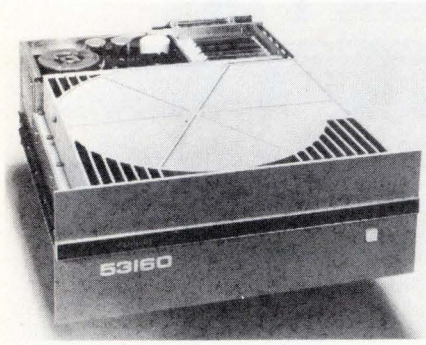
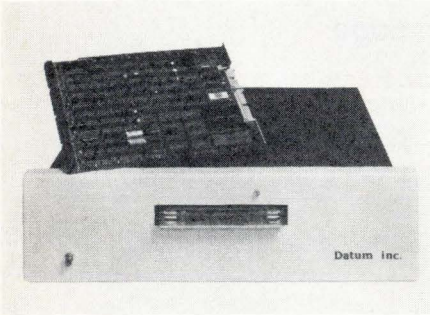


Winchester drive uses composite-head technology

The model 53160 14-in. fixed Winchester disk drive uses composite-head technology to provide 165M bytes of unformatted capacity. The heads incorporate calcium-titanate slider material encompassing a thin ferrite core to reduce magnetic fringing and permit track densities of 680 tracks per in. Data density is 6330 bits per in. Software- and hardware-compatible with SMD-type controllers, the model 53160 has a data transfer rate of 1000 bytes per sec. Average access times are 30 msec., and MTBF is 10,000 hours. In 500-unit quantities, the model 53160 is priced at $4075, including power supply and SMD interface. **Kennedy Co.,** 1600 Shamrock Ave., Monrovia, Calif. 91016. **Circle No** 317

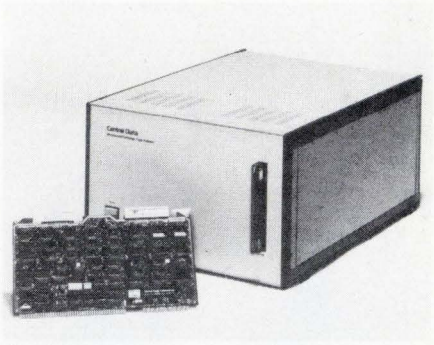


Streamer for IBM Series/1 has 90-ips speed

The model DSC 50 ¼-in., cartridge-tape streaming subsystem for the IBM Series/1 computer provides data storage backup for Winchester and removable disk drives. It has a tape speed of 90 ips and a transfer rate of 87.2K bytes per sec. Formatted data capacity is 20M bytes on four tracks. Recording density is 8000 bpi. Components of the DSC 50 include a single-board Datum tape controller, a ¼-in. magnetic-tape transport and an integral power supply. The controller board mounts directly into the IBM Series/1 processor chassis, while a separate enclosure houses the remaining components in a vertical, 5¼-in. space. The DSC 50, including cables, is priced at $3500, with OEM discounts available. **Datum, Inc.,** 1363 S. State College Blvd., Anaheim, Calif. 92086. **Circle No** 318

Mass-storage device uses DRAM technology

The Interstellar solid-state disk-drive emulator uses second-generation, high-density, 64K-byte dynamic RAM technology to provide a fast mass-storage device. Its access time is less than 10 msec., and its transfer rate is as high as 2M bytes per sec. The basic unit consists of 256K bytes of storage, user expandable to 1M byte, an appropriate interface card and all cabling. Battery backup eliminates data loss resulting from power failures and retains data after the computer is turned off. The Interstellar drive includes an independently regulated power supply to prevent power drain from the host microcomputer. It interfaces with most popular microcomputers, including the Apple II, TRS-80 model III, SS50 and S-100. Introductory price is $1095, including drives, diagnostics and utilities software. **PION Inc.,** 74 Appleton St., Arlington, Mass. 02174. **Circle No** 319



Subsystem combines Winchester, tape backup

The D4000 series subsystem features a fixed, 8-in. Winchester disk drive and ¼-in. streaming cartridge-tape drive backup in one cabinet. The subsystem is available in three models: model D4001 stores 10M bytes, model D4002 stores 20M bytes, and model D4004 stores 40M bytes. The tape drive portion of all models stores 20M bytes. The hard disk has a 5M-byte-per-sec. transfer rate and a 35-msec. average access time. The four-track tape drive features a 7600-bpi recording density, a speed of 90 ips and a data-transfer rate of 100K bytes per sec. These subsystems are priced at $8485 to $10,460 per unit, including controller. **Central Data Corp.,** 1602 Newton Dr., Champaign, Ill. 61820. **Circle No** 320

5¼-in. profile tape drive features streaming

The Slider ¼-in. digital cartridge-tape drive has the dimensions of an industry-standard 5¼-in. Winchester disk drive. The two-track drive features streaming operation with 10M bytes of capacity. Using the standard ANSI 450-ft. magnetic-tape cartridge, the

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CIRCLE NO. 195 ON INQUIRY CARD

drive incorporates Group Code Recording and a recording density of as much as 10,000 flux reversals per in. Transfer rate is 90K bytes per sec., depending on controller design. The Slider is available in three models with speeds of 30, 60 and 90 ips. All models have a 90-ips rewind speed. In 1000-unit quantities, the Slider is priced at approximately $550. **Data Electronics, Inc.,** 10150 Sorrento Valley Rd., San Diego, Calif. 92121.

Circle No 321

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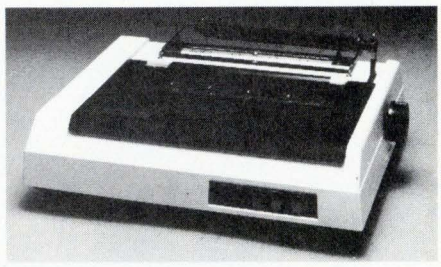

MAISEY printer offers near-daisy-wheel quality

Using the MAISEY printer technique, the Microprism dot-matrix printer offers print quality approaching that of a daisy-wheel printer. MAISEY describes a dot-matrix printer that can print correspondence-quality text in a single pass. The Microprism prints at 75 cps in correspondence quality and 110 cps in high-speed data mode. It also features an RS232 interface and Centronics-compatible parallel interfaces. Price is $799. **Integral Data Systems, Inc.,** Milford, N.H. 03055.

Circle No 322

Band printer is compatible with IBM System 34/38

B-Series printers are plug-compatible with the IBM Series 34/38. The printers are available in speeds of 300, 600 or 1000 lpm and are attached to a host through a 5256 workstation controller port via a twin-axial cable and connector. All interface components are housed within the printer. The B-Series features LED diagnostic status display, self-test, a cartridge ribbon, 64-character set, a forms-length selector switch and one- to six-part forms capability. Form sizes range from 3 to 16 in. wide and 3 to 14 in. long. The 300- and 600-lpm models are pedestal mounted, and the 1000-lpm model has a full cabinet enclosure. Prices range from $7500 to $14,000. **Digital Associates Corp.,** 1039 E. Main St., Stamford, Conn. 06902.

Circle No 323

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Siemens Model 2712 puts it all together: exceptional print quality...high reliability... economical performance. It's everything you want in an ink-jet printer—and more—all in one compact super-silent unit.

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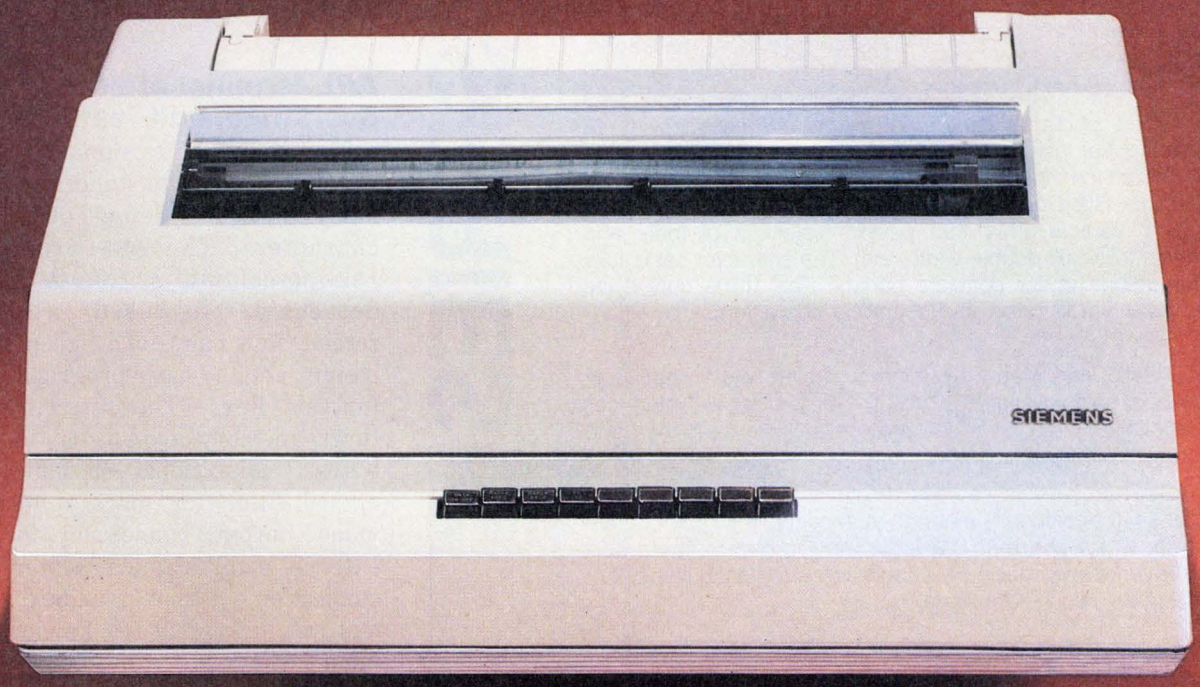

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CIRCLE NO. 197 ON INQUIRY CARD

Text and graphics terminal is user-programmable

The BitGraph high-resolution text and graphics terminal combines raster-scan technology with the Motorola MC68000 microprocessor. Priced at $4995, the terminal features a black-and-white bit-mapped display (1024 × 768 pixels) that allows graphics to be combined with text, and characters of different sizes and styles to be interspersed. The BitGraph's MC68000 processor is user-programmable and permits local processing via programs down-loaded from the host. The terminal is available with 128K or 512K bytes of RAM, and is compatible with DEC VT-52, VT-100 and Tektronix 4010 terminals. It features a detachable VT-100-compatible keyboard. The BitGraph's vertically mounted screen can display 8½- × 11-in. pages. Options include a pointing device (mouse) and a Centronics-compatible printer interface. **BBN Computer Corp.,** 33 Moulton St., Cambridge, Mass. 02238. **Circle No** 324

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Model 8400 and Model 8410 are new, packaged, stand-alone, alphanumeric, bi-directional, flat bed, Slip/Document dot matrix printers. They print up to 40 columns at 12 characters per inch at 3 lines per second. Both models provide side or front form insertion; top and bottom-of-form sensors and adjustable Slip/Document Stop. The print head employs a 7-needle vertical array that permits selection of fonts and characters (5 × 7, double width, etc). The character set is fully alphanumeric under software control. The 100% duty cycle print head life is rated at 100 million characters.

Model 8400 and Model 8410 are complete with control and drive electronics. Serial RS-232C or TTY and parallel interfaces are available. Both units can provide multiple print lines and carbon or pressure sensitive copy.

Model 8410 additionally features a stepping motor paper drive system which permits variable and programmable forward/reverse line spacing for applications requiring line selection and/or unique form indexing.

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CIRCLE NO. 198 ON INQUIRY CARD

APL terminal offers overstrike, edit features

The AJ 520/A terminal for APL users recognizes 70 standard and as many as 128 user-defined overstrike characters. The ANSI-standard, 132-/80-column AJ 520/A has a detachable keyboard, a 15-in. screen, four pages of English setup menus and 24 user-programmable function keys. The terminal features memory expansion to 21K bytes, bidirectional scrolling, an optical filter for glare reduction, video output connection for an external monitor and a printer-port connection. Other standard APL features include an APL keyboard, a numeric keypad with APL plus, high minus and ravel keys, automatic or menu-driven character-set selection, status-line indicator or character set, automatic line wraparound in APL and wrapped-line indicator. Single-quantity price is $2495. **Anderson Jacobson, Inc.,** 521 Charcot Ave., San Jose, Calif. 95131. **Circle No** 325

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If you service or maintain a range of computer peripherals OASIS 820 is the cost-effective and logical solution to your control and exercising problems.

OASIS 820 uses firmware application Peripheral ALgorithm Modules (PALMs) to configure the keyboard to control various computer peripherals. To test a printer, plug in a printer PALM — for a floppy disc drive, a floppy disc drive PALM. The same principle applies to terminals, accessories such as front feeds, hard discs, cartridge tape drives, etc. As and when different new peripherals have to be supported more PALMs can be added to the library.

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the revolutionary multiperipheral exerciser in a briefcase
-tests virtually any computer peripheral

Each PALM comes with a set of instructions so that various drive routines within the PALM can be selected from the "soft" keys on the keyboard. The operator is prompted through the tests by a display panel so that progression through each test can be constantly monitored.

OASIS 820 is not only low-cost in its basic form, but is also flexible and expandable. Each briefcase will hold several PALMs and interface cables so that an engineer can carry, in one hand, all of the peripheral driving equipment which he needs. Because OASIS 820 replaces any number of test boxes, the cost per function is minimal so that a Service Engineering Department can plan ultimately to have one briefcase for each engineer. *In the field of peripheral testing this gives OASIS 820 the lowest cost per function in the industry.*

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CIRCLE NO. 199 ON INQUIRY CARD

Color display station is 3279-interchangeable

The model 2079 color display stations are interchangeable with the IBM 3279. They display alphanumeric data and business graphics in as many as seven colors. Designed to operate in IBM SNA/SDLC or bisynchronous environments, a 2079 allows operators to enter alphanumeric data and special APL and text characters and to retrieve that data in alphanumeric and graphic form from the IBM Systems 360, 370, 303X, 3081, 43XX, 8100 and Amdahl processors. Three models of the 2079 include a keyboard numeric lock, an audible alarm and an unprotected field indicator. Model S2A is a 1920-character, four-color unit, providing red, blue, green and white and a choice of three keyboards. The S2B seven-color unit adds turquoise, pink and yellow, and provides extended highlighting, APL/Text and a choice of three keyboards. The S3G offers graphics, seven colors, extended highlighting, APL/text a choice of three keyboards and a screen capacity of 2560 characters. Prices start at $4395. **Memorex Corp.,** San Tomas at Central Expressway, Santa Clara, Calif. 95052. **Circle No** 326

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Digital Engineering is offering new GEN.II™ Retro-Graphics terminal enhancements for TeleVideo's® 910, 912, 920, 925 and 950, Lear Siegler's ADM 3A, 3A+, and 5, and the ADDS Viewpoint.

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CIRCLE NO. 290 ON INQUIRY CARD

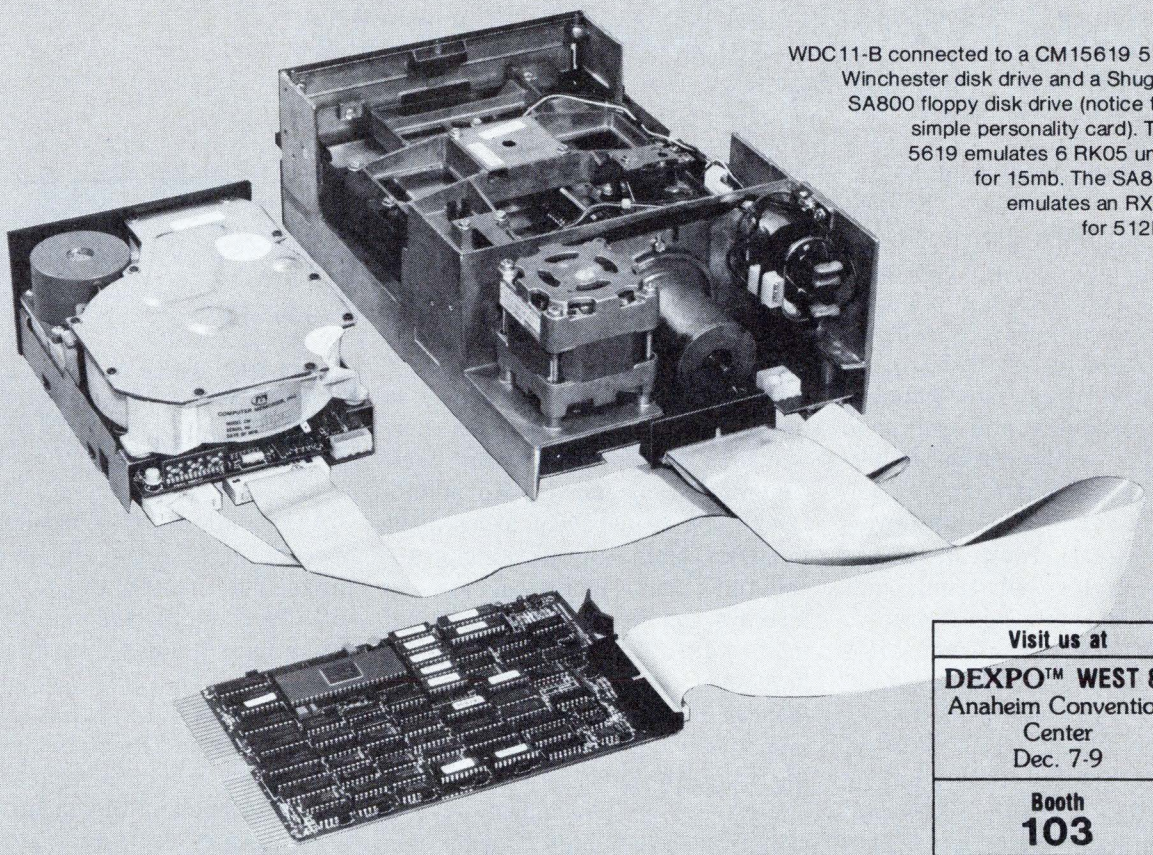
Color terminals use VLSI technology

The models 210, 220 and 230 color terminals incorporate a VLSI graphics processor chip and a 16-bit microcomputer that supports as much as 128K bytes of program storage. All three terminals offer a palette of 4096 colors, of which 16 can be displayed simultaneously. An interactive color setup mode allows a user to select and preview the colors from the full palette. The terminals support alphanumeric scrolling, windowing, double-height and double-width characters, blinking and underlining. The model 210 also has a standard graphics character set. The model 220 adds high-speed drawing of vectors as well as hardware zooming and panning features that allow a user to view a portion of the screen in greater detail. The model 230 features scaling, rotating and area fill. Objects can include any combination of vectors, arcs, rectangles, circles, polygons and text. Single-quantity prices are $3450 for the model 210, $4950 for model 220 and $6950 for the model 230. **Envision Corp.,** 683 River Oaks Parkway, San Jose, Calif. 95134.

Circle No 327

The WDC11 series...

The FIRST family of Winchester/Floppy controllers for the LSI-11/Q-Bus



WDC11-B connected to a CM15619 5¼" Winchester disk drive and a Shugart SA800 floppy disk drive (notice the simple personality card). The 5619 emulates 6 RK05 units for 15mb. The SA800 emulates an RX02 for 512kb.

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Unsurpassed Freedom Of Choice

Choose the **disk drive sizes** that are right for YOUR application: The WDC11 controls 8" and 5.25" drives, Winchester and floppy.

The **DEC emulations** that YOU need: RK05, RL01/02, RP02 for the Winchester and RX02/03 for the floppy. All Winchester emulations provide 22-but addressing; RLV21-compatible.

The **disk drive vendors** that YOU want to use: The Following manufacturers build drives that are currently supported: Shugart, Quantum, Tandon, Qume, Computer Memories, Disctron (RMS), Rodime, Ampex, Micro Peripherals, Seagate. Any drive with a standard interface (SA1000, SA800/850, ST506, or TM100-4) can be controlled by the WDC11. A single PROM chip adapts the WDC11 to a specific drive configuration.

The **controller form-factor** YOU want: A single, dual-width card includes the Winchester controller, the floppy controller and an intelligent bootstrap. There is no external formatter board that you need to mount and supply power to. The WDC11 requires only 2.7A of +5V. Simple personality cards adapt the WDC11 to multiple drives, various pinouts and signal levels.

The **experience** YOU are looking for: Andromeda has been shipping WDC11's since the Summer of 1981.

The **growth potential** that YOU require: As new, higher capacity, higher performance disk drives become available, the WDC11 can be adapted to them by simply changing the configuration PROM. New emulations and data formats can be handled in a similar fashion.

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CIRCLE NO. 291 ON INQUIRY CARD

Limited-distance modems operate at 56K to 2.5M bps

Operating at speeds from 56K to 2.5M bps, a family of limited-distance modems from Avanti Communications Corp., Newport, R.I., provides high-speed point-to-point or optional multipoint communications capabilities. Designated the 2300 local area data distributors, the products will serve in three major configurations—CPU-to-CPU communications, CPU-to-high-speed-terminal communications and as local gateway devices to and from high-speed trunk networks such as satellite networks.

A key feature of the 2300 series modems is a switch-selectable equalizer, says Aurelio Lucci, Avanti's president. This feature, which frees users from making internal-device adjustments to compensate for signal distortion, is part of the company's attempt to make the modems as user-friendly as possible, he says. The products are also available with as many as four switch-selectable data rates within a specified range.

Some members of the 2300 series act as direct replacements for the more expensive Bell 306 modem on T1 digital links with a DSX-1-compatible interface. Aside from a price advantage, the 2300s also provide 200K bps over the Bell 306 terminal rate, says Lucci. While both the Bell and the Avanti modems provide line rates of 1.544M bps, the Bell device's terminal rate is just 1.344M bps. Lucci says the 2300s use a proprietary method similar to a scrambler to maintain a terminal rate of 1.544M bps.

The 2300 product line features local analog and remote digital loopback diagnostics. Front-panel indicators provide information on test status and indicate the test-initiating station. The loopback function can be initiated manually or automatically. Bit-error rates for the 2300 products are better than 10^{-9}.

Richard Berger, vice president of marketing, says the 2300 series offers an immediate alternative to users waiting for local-area networks to fill their high-speed communications needs. He admits the totally transparent 2300s don't impose a common networking protocol to permit unlike devices to interact—an important aspect of many LANs. But, Berger says, the high-speed modems are the best answer for users wanting to connect high-speed devices already operating under the same protocols.

Because few terminal devices require the very high transmission speeds provided by the 2300 products, Berger says, the major initial markets for the modems will be CPU-to-CPU communications and linking satellite networks to local sites.

Avanti's 2300 series of limited-distance modems *operate at 56K to 2.5M bps over shielded twisted-pair and coaxial cable. The modems are available in desk-top (above) or rack-mountable configurations.*

Avanti offers three products that operate in the 56K- to 46.8K-bps range. The 2335M with a CCITT V.35 interface sells for $1825, the RS449/442-equipped 2349M sells for $1800, and the Bell 301/303-type 2303M sells for $2025, all in single-unit quantities. In the 461K- to 2.5M-bps range, the 2335H with a V.35 interface and the 2349H with a 449 interface sell for $1975 and $1950, respectively. Quantity discounts are available for all models.

—Dwight B. Davis

Avanti Communications Corp., Aquidneck Industrial Park, Newport, R.I. 02840. **Circle No** 328

T1 modem uses fiber optics

The model CSY-306T1 modem is directly plug-compatible with high-speed, T1-type, 1.5440M-bit-per-sec. data devices and provides an interference-free and virtually error-free data channel over distances as great as 2 km. The fiber-optic product replaces conventional wire cable in T1 data-link applications such as satellite down-link circuits, CAD/CAM installations and CPU-to-CPU communications. It has a bit-error rate of one in 10^9 or better. The fiber-optic cable used between the ends of the full-duplex link can be routed adjacent to existing

power lines or conduits and is immune to EMI/RFI and unauthorized tapping or monitoring of data. Available in stand-alone or rack-mount packages, the CSY-306T1 is priced at $1800 in single-unit quantities. **Canoga Data Systems,** 212 Vanowen St., Canoga Park, Calif. 91303. **Circle No** 329

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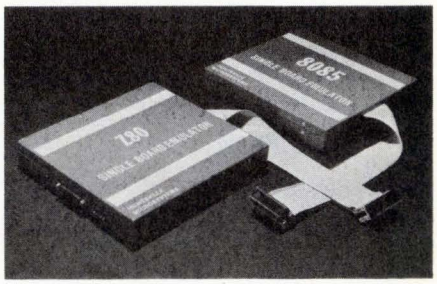
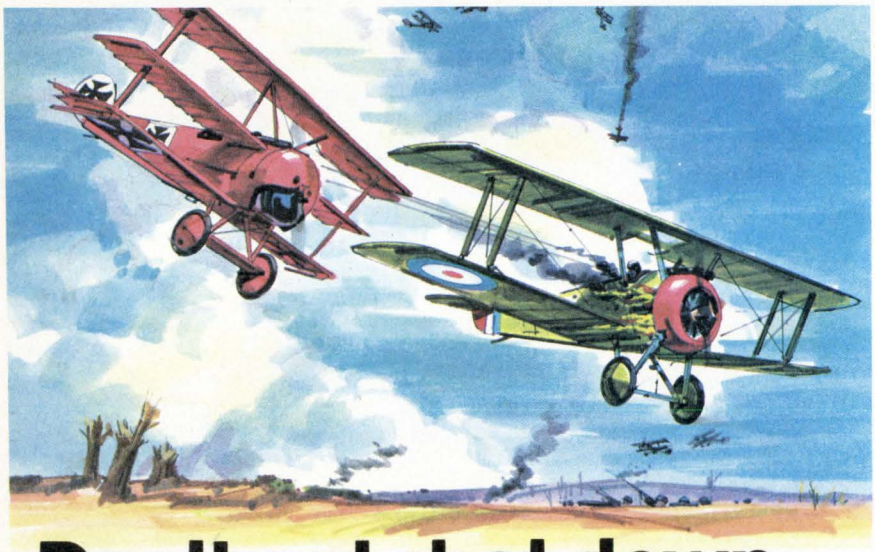
The SBE-80 and SBE-85 in-circuit emulators for testing and debugging hardware and software of Z80- and 8085-based systems provide real-time emulation as fast as 6 MHz with a hardware breakpoint, 16K bytes of static RAM and an RS232 interface for operation with a terminal or host computer. Linking software to allow operation with CP/M via RS232 is optional. The command sets give an operator control over single-stepping, examining and modifying registers or memory, an in-line



assembler, a disassembler and up- and down-loading hex files in Intel format. Other commands include fill memory block, move block, compare blocks and test block, as well as direct I/O operations. Each in-circuit emulator is built on one board and packaged in a 9¼- × 8¾- × 1½-in. case. Memory is implemented using 2K × 8 static RAMs. Prices are $1895 for the SBE-80 and $1695 for the SBE-85. **Huntsville Microsystems,** P.O. Box 12415, Huntsville, Ala. 35802. **Circle No** 330

Analog output board operates at 800 KHz

The DT3366 LSI-11-bus-compatible D/A converter drives as many as eight 12-bit D/A channels directly from memory at transfer rates as high as 400 KHz without processor intervention. When used with the vendor's DT3369 dual-port RAM board, the DT3366 can transfer data from memory at 800 KHz via an external bus. Its multiplexer channel-list, an on-board 1024-byte RAM, is divided into four 256-byte pages. The processor has read/write access to this RAM so that it can store the channel numbers for output. The DT3366 has four data-transfer modes: interrupt-driven, programmed I/O, LSI-11-bus DMA and external-port DMA. Each can be combined with software-controlled or external triggering schemes. In single-unit quantities, the DT3366 is priced at $2195 for the four-channel version and $2595 for the eight-channel version. **Data Translation,** 100 Locke Dr., Marlboro, Mass. 01752. **Circle No** 331



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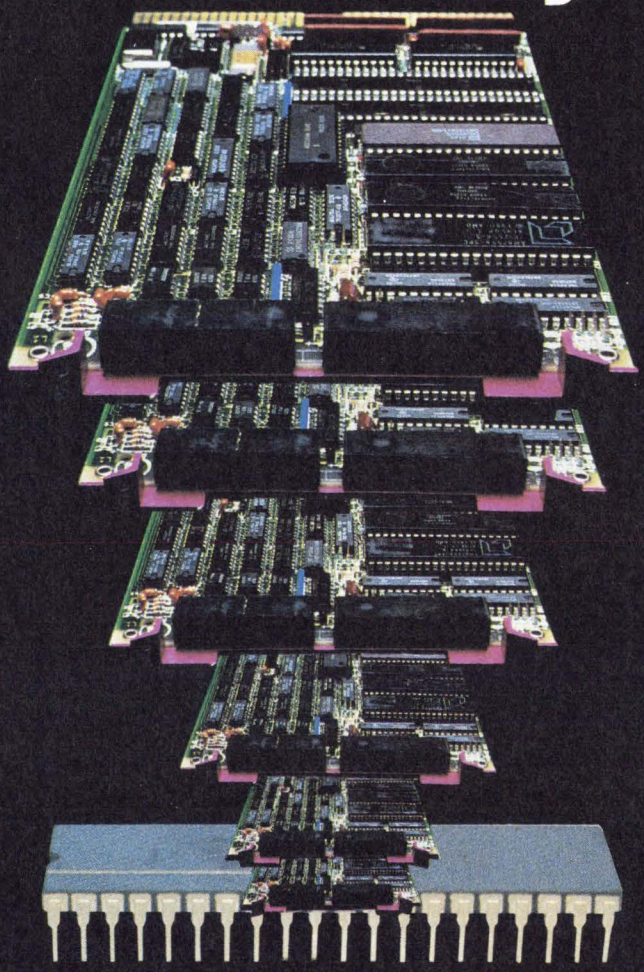

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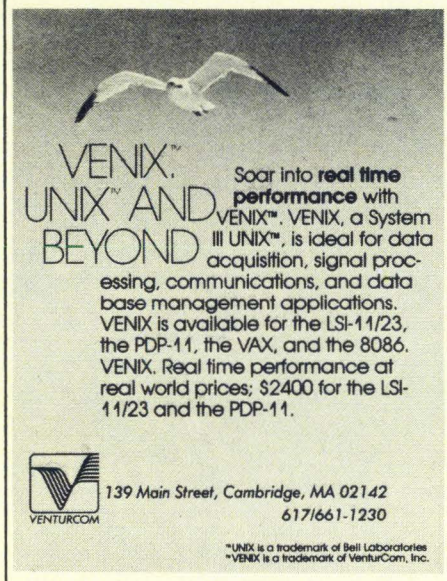

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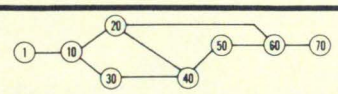

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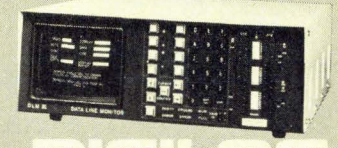

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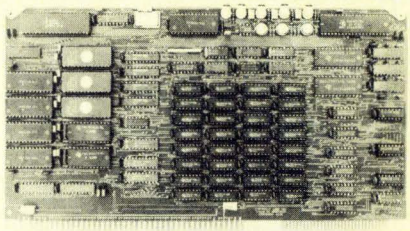

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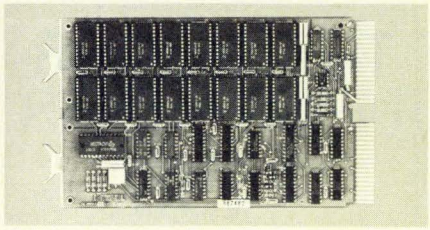

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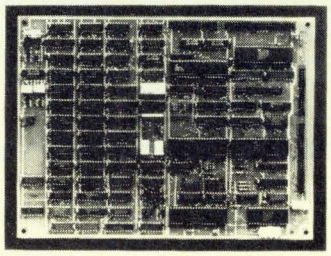

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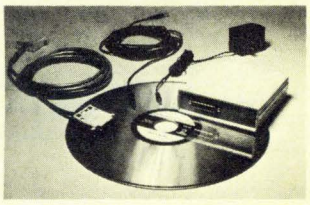

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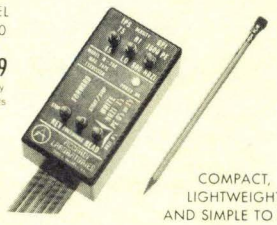

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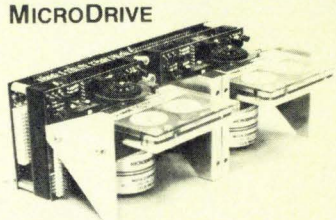

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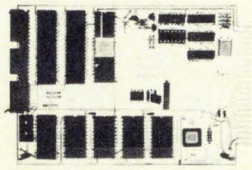

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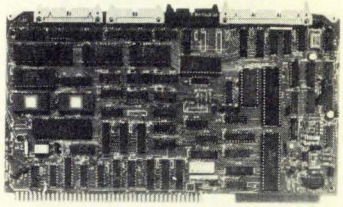

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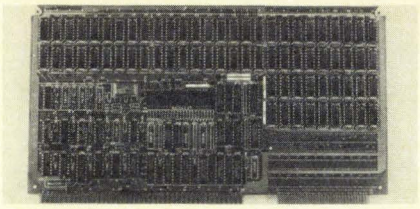

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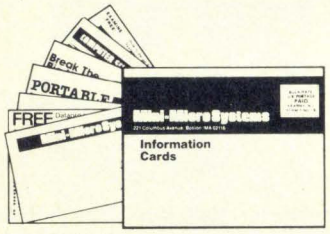

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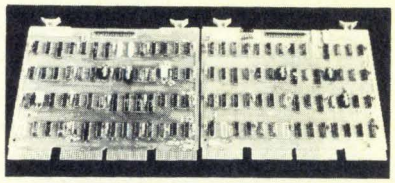

New DEC-compatible shared memory link obsoletes traditional CPU links.

The PPL-1 Peripheral Processor Link is a unique shared memory interface between any two Q-bus (LSI-11) and/or Unibus (PDP-11)-based DEC CPU's. Two quad boards and a connecting cable link the peripheral unit with the host. Up to 32KB of memory can be accessed by the peripheral processor in 4KB boundaries anywhere in the address space of the host. Address spaces are 18 bits for Unibus and 22 bits for the Q-bus. This memory sharing does not require software to support the link. 16 vectored interrupts (8 from each direction) provide necessary hardware for protocol implementation.

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Literature

NEW PRODUCTS

Quartz products described in brochure

Quartz products for the semiconductor industry and laboratory applications are described in a four-page reference catalog. Descriptions and pictures of tubing, rods and plates; diffusion boats; paddle systems; and accessories are included. **Fluorocarbon Co.,** 17 Madison Rd., Fairfield, N.J. 07006.

Circle No 332

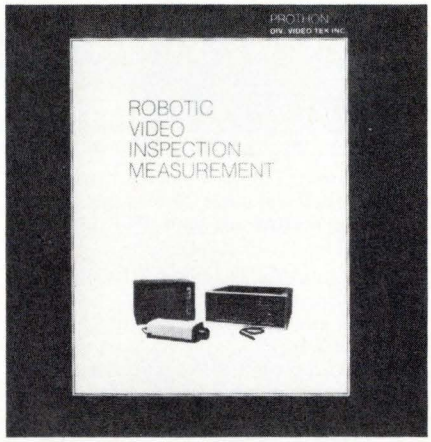
Brochure details switching system

The SL-10 packet-switching system is featured in a six-page brochure. The publication covers switching technique, automatic error checking, network-management capability, data communications and transmission facility usage. **Northern Telecom, Business Communications Systems,** 1001 E. Arapaho Rd., Richardson, Texas 75081.

Circle No 333

Directory lists 250 software packages

More than 250 general and specific application programs for the vendor's word and data business-processing systems are listed in a software directory. Contents are grouped into 16 categories, including data management; general business accounting; word processing; and applications for manufacturing, professional services and trades, such as architecture, construction and surveying. Each package is listed by name and function, and all hardware, software, memory, operating system and language requirements are specified. The directory provides a list of where packages can be purchased, prices, two user references and the number of installations. **Vector Graphic, Inc.,** 500 N. Ventu Park Rd., Thousand Oaks, Calif. 91320. **Circle No** 334



Brochure describes robotic vision system

The Prothon 1000 robotic vision system is described in a brochure. The six-page publication presents the system's uses in production, engineering design, quality control, process control and robotics. It explains how the system inspects, measures and controls, and diagrams illustrate applications including inspection, measurement, process control, sorting, monitoring, identifying and counting. **Prothon Division of Video Tek Inc.,** 199 Pomeroy Rd., Parsippany, N.J. 07054. **Circle No** 335

Publication outlines touch applications

The applications of touch-sensitive computer display technology are described in a brochure. Applications include consumer, employee, executive and general use. **Interaction Systems, Inc., Marketing Department,** 24 Munroe St., Newtonville, Mass. 02160.

Circle No 336

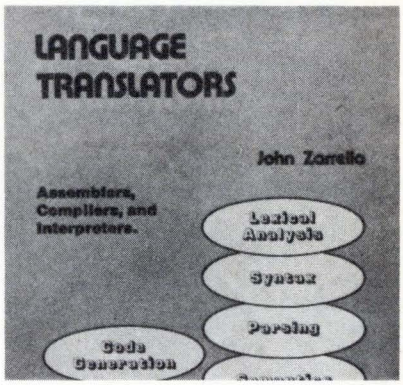
Government regulations discussed in brochure

Advances in LSI modem technology, changes in government regulations affecting data transmission and the resulting trend toward incorporating modems as subsystems in microcomputer-based equipment are discussed in a 12-page, color brochure. The brochure also covers the vendor's 2400- and 9600-bps modem subsystems and modules. **Rockwell International, Electronic Devices Division, Sales Support Services,** RC55, P.O. Box 3669, Anaheim, Calif. 92803. **Circle No** 337

Graphic systems featured in brochure

The VIA 100 series of interactive graphics systems is described in a brochure. The brochure details system hardware, graphics software, distributed communications, user support, design aids, hierarchical design, pattern generation and system productivity. **VIA Systems, Inc.,** 11 Concord St., Nashua, N.H. 03060. **Circle No** 338

LITERATURE THAT COSTS



Language translators described in book

An easy-to-understand introduction to assemblers, interpreters and compilers is presented in *Language Translators* by John Zarrella. The 200-page, $12.95 book explains program-source text analysis, parsing, code generation and optimization. Five chapters introduce assemblers, interpreters and compilers, and six chapters detail examples of lexical analysis, syntax analysis, code generation and optimization techniques. The book also discusses macros, symbol tables and error processing. **Microcomputer Applications,** 827 Missouri St., Fairfield, Calif. 94533.

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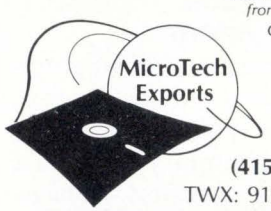

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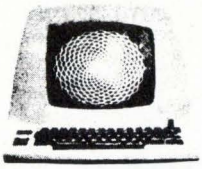
FOR  THE

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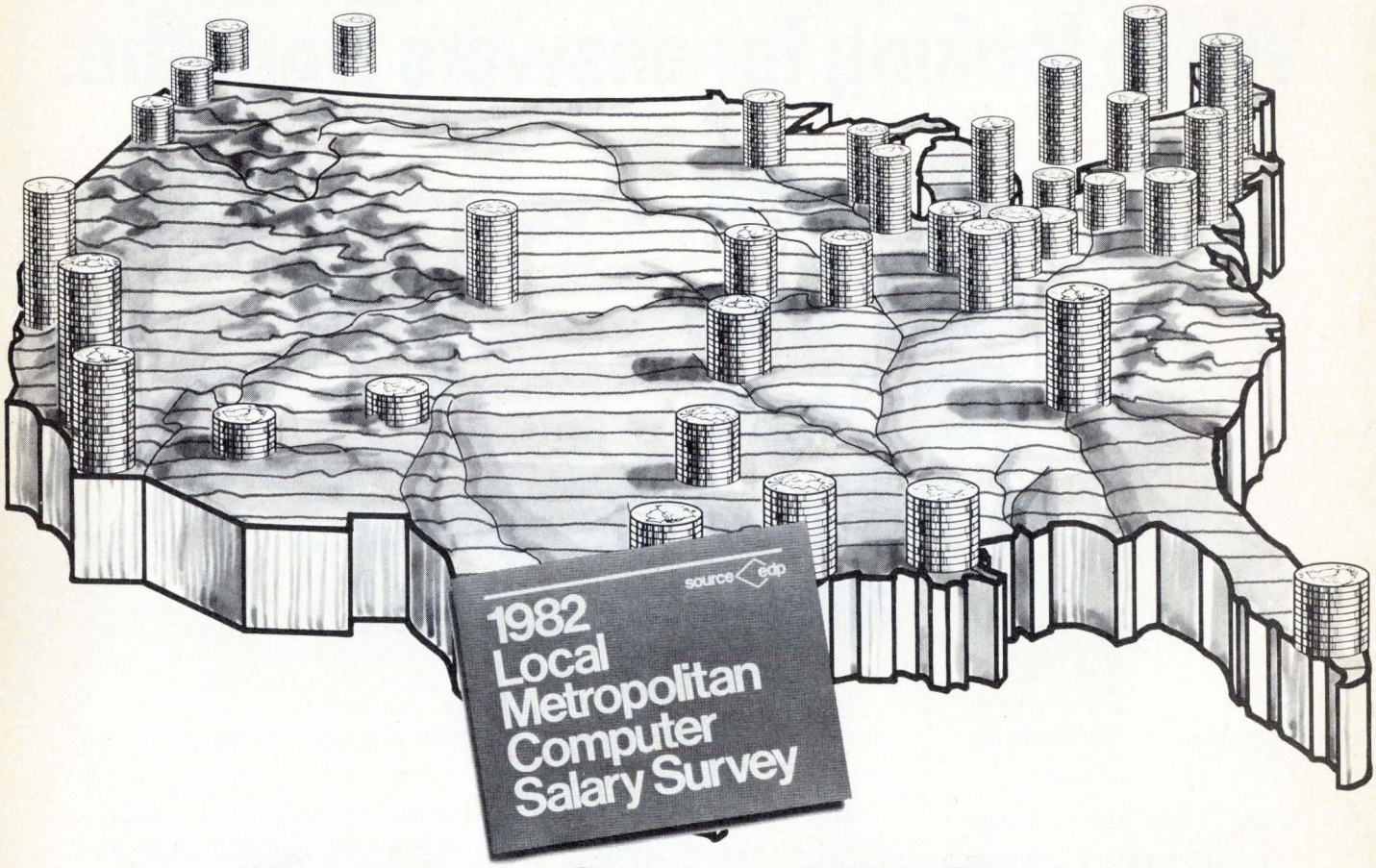

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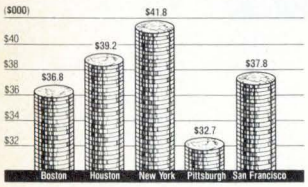

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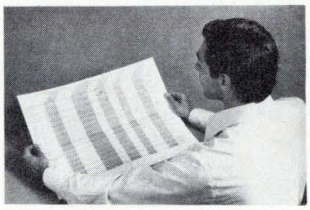

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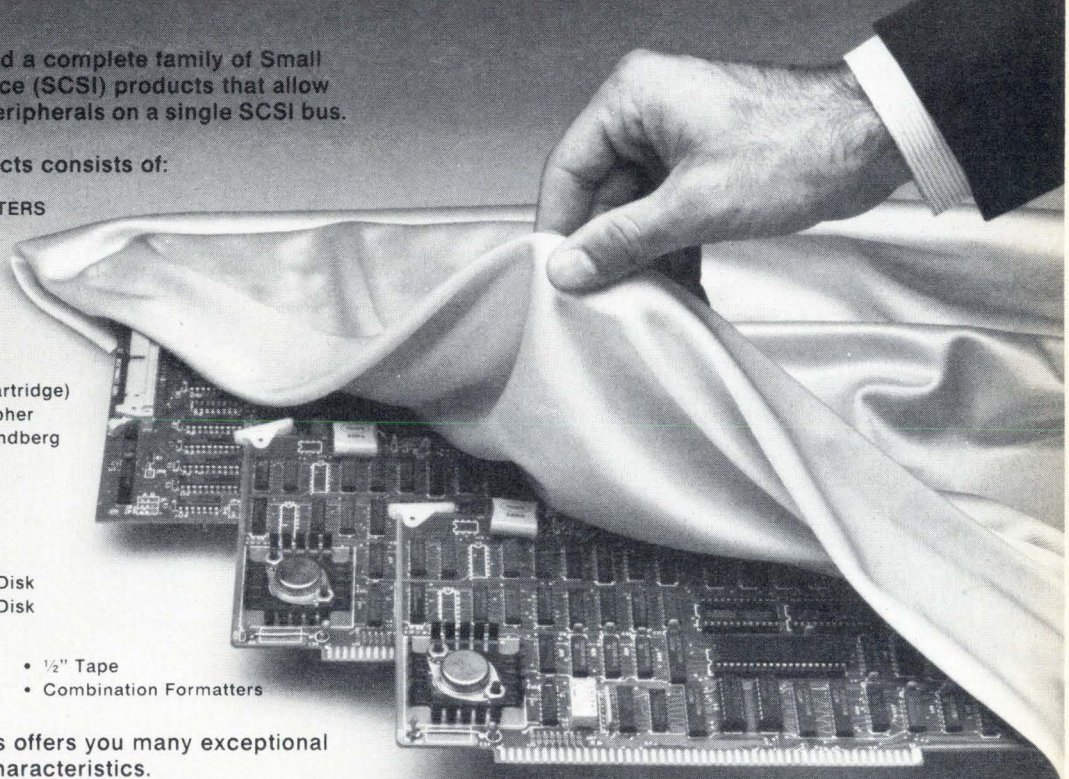

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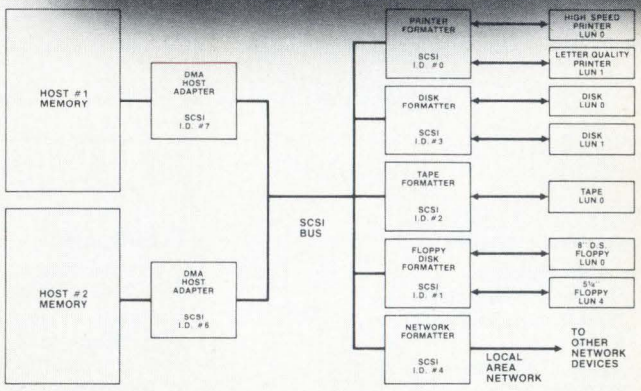

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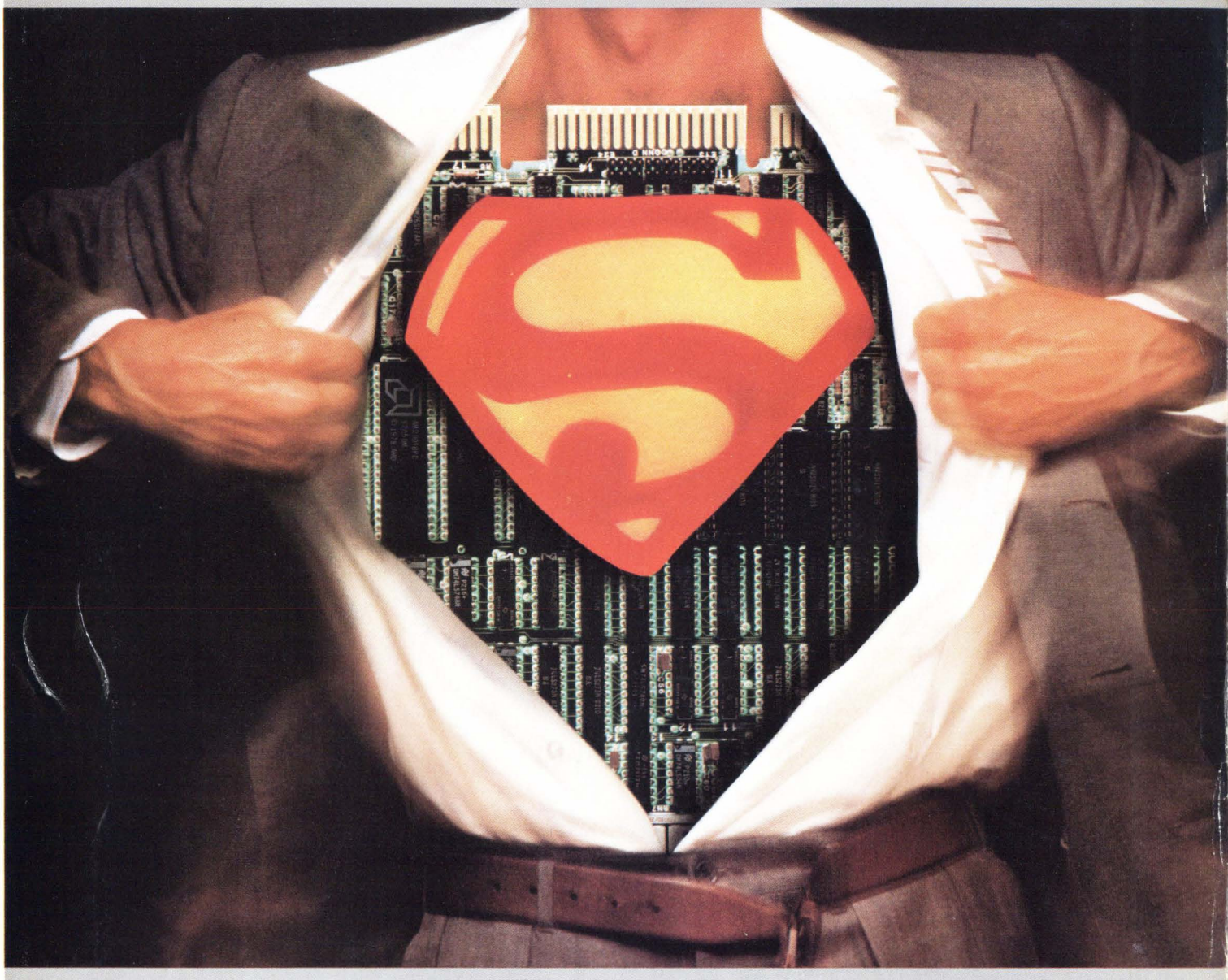

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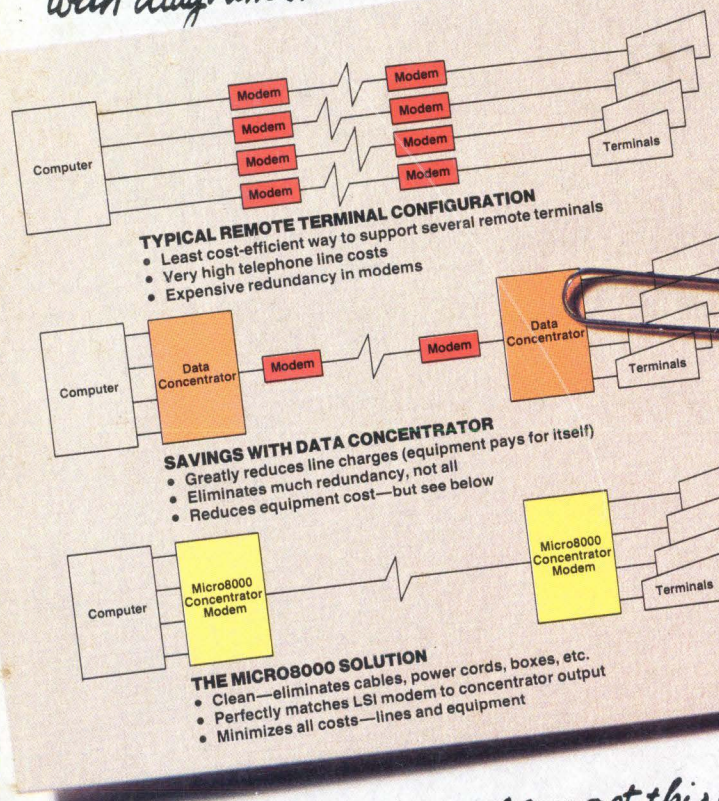

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chris

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